WEST VIRGINIA GEOLOGICAL SURVEY

PLATE I— "Hanging Rocks" (Pomeroy Sandstone) Hartford, Mason County.

WEST VIRGINIA

GEOLOGICAL SURVEY

Jackson, Mason and Putnam Counties

By

CHARLES E. KREBS, Assistant Geologist

I. C. WHITE, State Geologist

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LETTER OF TRANSMITTAL

To His Excellency, Hon. William E. Glasscock, Governor of West Virginia, and President West Virginia Geological Survey Commission:

Sir: I have the honor to transmit herewith, the Detailed County Report and accompanying geologic, topographic and soil maps of the counties of Jackson, Mason and Putnam, prepared by Assistant Charles E. Krebs. This is Mr. Krebs' first Report for the Survey, and reveals careful work. He in conjunction with Mr. Teets, his Assistant, has just completed the field work for another Report on the adjoining counties of Cabell, Wayne and Lincoln, which he will have ready for printing early in 1912.

The under-ground wealth of Jackson county remains as yet almost entirely undeveloped, since only a few small oil wells have been found within its boundary, while no natural gas wells of commercial value have been drilled, although many tests for both gas and petroleum have been made. The entire area of Jackson county comes within the barren zone of coal deposition, and hence there is probably very little coal of commercial value underlying any portion of the county. This is proven both by diamond drill borings and tests for oil and gas, the coal sometimes reported in these latter drill holes being in most cases only bituminous slates, as shown by core drill holes.

Mason county has a limited coal field in the vicinity of Hartford, and surrounding towns, and Putnam county has the same coal at Plymouth, Raymond City, and along the waters of Pocatalico. There are small isolated Pittsburgh coal areas west of the Kanawha river both in Mason and Putnam, but no pools of either oil or gas have yet been developed in Mason, or the northern half of Putnam. Mr. Krebs prefers to identify the principal coal bed in both Mason and Putnam counties (often known as the Pomeroy coal) with the Pittsburgh seam instead of the Redstone coal with which Prof. Bownocker, State Geologist of Ohio, prefers to correlate the Pomeroy coal. The exact identity of the

coal in question is of no special economic interest, since only one commercial coal is ever present in the same section at this horizon in these counties. Hence the question as to identity of the Pomeroy coal can well be left open until the eastern crop of the known Pittsburgh and Redstone coals can be traced southwestward through Lewis, Gilmer, Braxton, Clay, and Kanawha to Putnam county, since there can be little doubt that the Pomeroy, or Hartford coal of Mason, is the same bed as the Plymouth and Raymond City coal of Putnam county.

Many persons have wondered why no prolific oil and gas fields have been developed in Jackson, or Mason counties, or the northern half of Putnam. As explained in this Report, this absence of oil and gas pools from the area indicated, appears to be due to the fact that the main broad syncline or basin of the Appalachian coal field passes through these counties, thus depressing all the oil and gas sands to such a depth that they are filled with salt water, when porous, to such an extent that the little oil and gas present cannot segregate into pools of commercial value, because the dips are very gentle, and no prominent anticlinal waves or arches in the rocks traverse the area until we pass into the southern half of Putnam county, where as the dips steepen we find the geologic conditions under which these hydro-carbons can accumulate into pools of considerable quantity. Hence, outside of brick and pottery clays and shales, and sandstones for building and grindstone purposes, the salt industry from brines, and the limited coal fields mentioned, the main reliance for the future prosperity of the citizens of these three counties must continue to rest upon the products of the soil. The thorough study and descriptions of the several soil types of this district and the accompanying maps of the same as delineated by the experts of the United States Bureau of Soils, as well as the suggestions made in this Report for their enrichment and improvement as published on pages 297-354 of this volume, should be carefully read and pondered by the farmers of the areas in question.

Very respectfully,

I. C. WHITE, *State Geologist.*

Morgantown, W. Va., December 15th, 1911.

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ILLUSTRATIONS

Maps in Atlas.

Sketches and Maps.

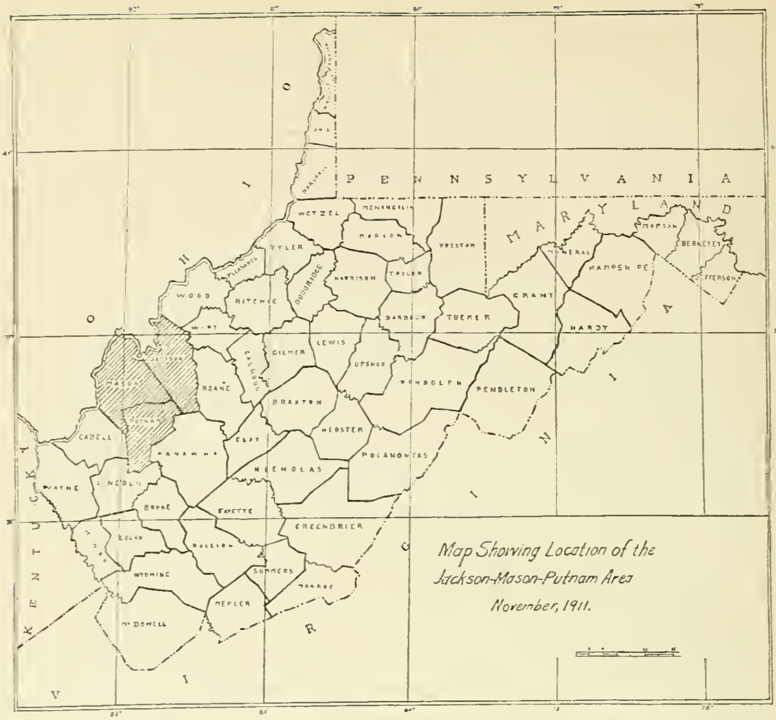
AUTHOR'S PREFACE

In writing the report of the Geology of Jackson, Mason and Putnam Counties it has been the purpose of the author to present the prominent features of their Geology and an effort has been made to state the facts in an intelligible style, not only to the residents of the area, but to the people of the State, keeping always in sight scientific accuracy.

The object of this volume is to collect and assemble the present knowledge of the economic resources, to publish the data collected by the writer in the field, and to present it in a form convenient for the use of those who are interested in the development of the Jackson-Mason-Putnam Area.

The report includes (1) a brief history of the counties and their development; (2) a study of the surface features of the counties; (3) the geological structure, with a contour map of the top of the Pittsburgh Coal Bed; (4) the general and detailed geology of the area, including sections and records of core drill holes and oil and gas wells; (5) the coal resources and the chemical composition of the coals; (6) clays, road materials, building stones, and the salt industry; (7) a chapter on timber; and (8) a chapter on the soils of the three counties; (9) precise levels of the area and railroad levels.

One of the most important features of this report is the determination and representation of geologic structure. The depth of the Pittsburgh coal horizon has been determined all over the area and a contour map constructed to show how it lies. These contours are exhibited on the economic geology map accompanying the report in a separate cover. By referring to this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GILMER
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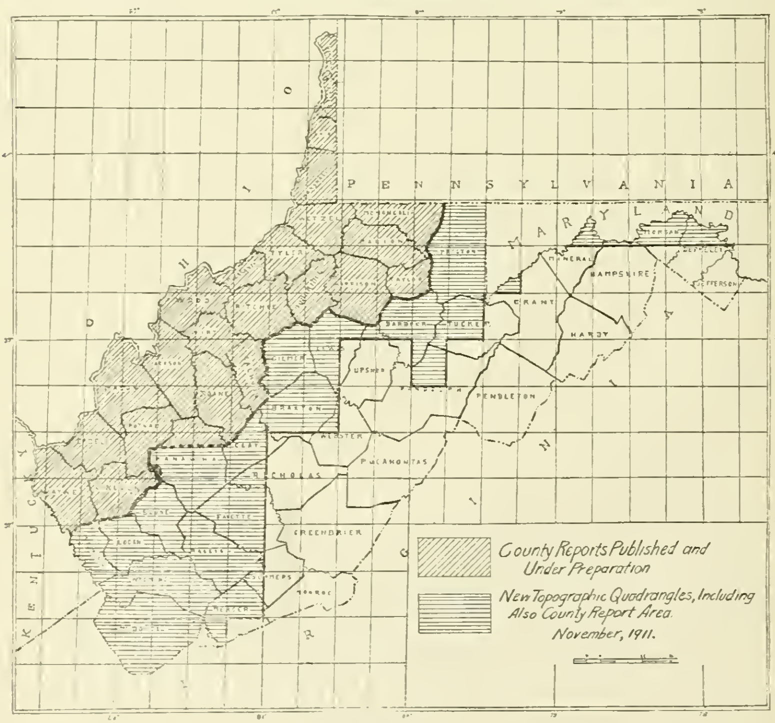
CALHOUN
UPSHUR
ROANE
RANDOLPH
PENDLETON
MASON
PUTNAM
CABELL
KANAWHA
BRAXTON
WEBSTER
CLAY
POCAHONTAS
WAYNE
BOONE
FAYETTE
GREENBRIER
LOGAN
SUMMERS
WYOMING
MONROE
MERCER
McDOWELL
Map Showing Location of the
Jackson-Mason-Putnam Area
November, 1911.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BRAXTON
WEBSTER
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KANAWHA
POCAHONTAS
FAYETTE
GREENBRIER
SUMMERS
MONROE
MERCER
County Reports Published and
Under Preparation
New Topographic Quadrangles, Including
Also County Report Area.
November, 1911.

PLATE II.

map the depth to the Pittsburgh coal horizon can be told approximately at a glance, and also the shape and location of the anticlines and synclines, a knowledge of which is of the greatest importance in the development of oil and gas pools, and also for the future mining of the several coal beds when of commercial thickness and purity.

The chapter on clays, road material and building stones is important, and also the chapter on the soils of the area cannot fail to be of especial interest to the progressive farmers. This chapter on Soils was prepared by Messrs. W. J. Latimer and C. N. Mooney of the Bureau of Soils at Washington, D. C., both well trained men with considerable practical experience in soil study.

Three maps of the entire area accompany this report in a separate cover, one of which shows by the use of colors the character of the surface, the roads, streams, railroads, etc.; another illustrates the economic geology by showing the outcrops of coal beds, mines, oil and gas wells, dry holes, structure contours of the Pittsburgh coal, and the approximate western boundary line where the latter of commercial thickness and purity disappears, the third, or soil map, shows by the use of colors the character and distribution of the soils.

Portions of two seasons were spent in the field by the writer in gathering data for this volume, and much valuable assistance was received from individuals and officials of the different companies engaged in the development of the coal, oil and gas resources of the area. Due credit and acknowledgement has been given in this volume for all such data obtained.

The chemical analyses were made in the Survey laboratory by Mr. J. B. Krak, Assistant Chemist, under the direction of Prof. B. H. Hite, Chief Chemist.

The writer takes pleasure in expressing his appreciation for

the aid of the State Geologist, Dr. I. C. White, whose writings and valuable suggestions from time to time in the preparation of this report have added much to its value and completeness.

The writer also takes this opportunity to express his obligation to Mr. Ray V. Hennen, Assistant Geologist, for valuable suggestions received in the preparation of this report.

Charleston, W. Va., July 15, 1911.

C. E. KREBS
Assistant Geologist.

PART I.

The History and Physiography of the Area Embraced by Jackson, Mason and Putnam Counties.

CHAPTER I.

THE HISTORICAL AND INDUSTRIAL DEVELOPMENT

LOCATION AND HISTORY.

The portion of West Virginia described in this report lies in the southwest part of the State, fronting on the Ohio river and extending along the same from the mouth of Pond creek at the southern boundary of Wood county, to the mouth of Guyan creek at the northern boundary line of Cabell county, a distance of about 82 miles. The area is divided into two segments by the Great Kanawha river which flows northwest through Putnam and Mason counties, a distance of about 44 miles, from Lock Seven on the Kanawha to Point Pleasant, where this river empties into the Ohio. The three counties contain an area of 1,274.86 square miles, as follows: Jackson, 470.29; Mason, 449.27; and Putnam, 355.33 square miles. The area contains important coals, some gas and oil, and rich agricultural and grazing lands.

HISTORY OF TRANSPORTATION.

The earliest settlements of this area were made along the Ohio and Kanawha rivers, which afforded the most convenient and best routes of entrance to the territory.

Ohio River.

For many years the Ohio river was used for the transportation of supplies to the settlers and for transporting their products to the northern and southern markets and also for passenger service. Even now the Ohio river is playing an important part in transportation, and Congress has recently appropriated funds and adopted a definite program to build locks and movable dams for furnishing slack water navigation throughout the entire course of this river.

The Kanawha River.

The Kanawha river is the largest stream in the western portion of West Virginia, and was early used for transportation purposes. Salt was first shipped down the Kanawha river in canoes, and the first shipment on a more practical scale was made in 1808 when a long raft was formed by fastening the logs together with hickory poles upon which a lot of salt packed into empty bacon hogsheads was loaded and floated down the river to the new settlements. *"The first steamboat to attempt the navigation of the river in early days of steamboating on the western waters was the Robert Thompson in 1819. She went as far as Red House Shoals, but lacking power to stem the swift currents in that place abandoned the effort and returned. In 1820 the Andrew Donnally, a steamer built by Messrs. Andrew Donnally and Isaac Noyes, salt makers of Charleston, made the first successful run to Charleston. The Legislature of Virginia in 1820-21 passed an order directing the James River and Kanawha Company to improve the navigation of the Kanawha so as to secure not less than 2 feet depth of water all the year around from the mouth of the river to the Kanawha Falls. The first work was done at Red House Shoals in 1825."

The United States Government has constructed ten locks on the Kanawha river between Point Pleasant and Montgomery, Lock No. 11 being located near the mouth of Kanawha river, and the proposed location of Lock No. 1 is just below

*Dr Hale's Early History of the Kanawha Valley.

PLATE III—Ohio River at Lock 26 Mason County.

the mouth of Lower Loup creek between Deepwater and Mt. Carbon. However, this lock has not been built. Lock No. 7 is located in Kanawha county about one mile below the mouth of Coal river and one-half mile south of the Kanawha and Putnam County Line, and is 44.15 miles from the mouth of Kanawha river. The lock has a movable dam and the elevation of the pool above this lock is 554.355 United States Geological Survey Level, or 550.50 War Department Levels. Lock No. 8 is located about two miles and three-fourths below the mouth of Pocatalico river and just above the mouth of Big Guano creek, about one-half mile north of Plymouth. The lock has a movable dam and the elevation of its pool is 546.105 United States Geological Survey Levels or 542.25 War Department Levels and has a lift or rise of 8 feet.

Lock No. 9 is located about three-fourths mile below the mouth of Little Buffalo creek and about one mile northeast of Woods. It has a movable dam and a 6 foot lift or rise. The elevation of the pool above the lock is 538.105 United States Geological Survey Levels, or 534.25 War Department Levels.

Lock No. 10 is located nineteen miles from the mouth of Kanawha river and about one-half mile south of the mouth of Eighteen Mile creek. It has a movable dam and has a 7 foot rise or lift. The elevation of pool above this lock is 531.855 United State Geological Survey Levels, or 528 War Department Levels.

Lock No. 11 is located about one mile and seven-tenths from the mouth of Kanawha river and has a lift of 10.92 feet. It has a movable dam, and the elevation of this pool above this lock is 524.855 United States Geological Survey Levels, or 521.00 War Department Levels.

Thus the Kanawha River has slack water navigation practically throughout the entire year.

RAILROADS.

The area described in this volume is traversed the entire length, on the western edge, by the Baltimore & Ohio Railroad along the Ohio river, and it is also traversed by the Rav-

enswood & Spencer Branch of the Baltimore & Ohio from Ravenswood to Liverpool, and the Ripley & Mill Creek Valley Railroad from Mill Creek Junction to Ripley.

The Kanawha & Michigan Railway runs through Mason and Putnam counties along the north bank of the Kanawha river.

The Chesapeake & Ohio Railroad enters Putnam county near Scary, and runs through the Teays Valley by way of Hurricane.

The Ohio River Railroad.

This railroad first began its existence under charter of the Wheeling & Pittsburg Railroad, in April, 1881, but its name was changed to the Ohio River Railroad in June, 1882. It was completed from Parkersburg to Wheeling in June, 1884, to Point Pleasant in January, 1886, and finally to Huntington and Kenova in April, 1888, the road being purchased by the Baltimore & Ohio Railway Company August 1, 1901, and is now a part of its system.

Ravenswood & Spencer Railway.

This railroad extends from Ravenswood to Spencer and was built in 1892 by local capital. It afterwards became the property of the Ohio River Railway and is now owned by the Baltimore & Ohio. Its length in Jackson county is about seventeen miles.

Ripley & Mill Creek Valley Railway.

This road extends from Millwood Junction, a point on the Baltimore & Ohio Railway eleven miles south of Ravenswood, to Ripley, a distance of thirteen miles. It was built in 1888 by local capital and afterwards became the property of the Ohio River Railway, passing with that road to the Baltimore & Ohio Railway. Mr. W. T. Greer was the first President and D. H. Hood was the first Treasurer. Both were largely interested in the building of this road.

Chesapeake & Ohio Railway.

This road was first commenced in 1834 and was finally completed to Charleston in 1873. The line of the C. & O. Railway through Teays Valley has been recently relocated and double tracked and practically a new road bed has been constructed from Scary to Barboursville.

HIGHWAYS.

The Charleston and Point Pleasant Turnpike, following the east bank of the Kanawha river between the above points, was built in 1838. The Charleston and Ravenswood Turnpike, a road running from Charleston by way of Sissonsville, Kenna, Ripley to Ravenswood, was constructed in 1856-61. The Reedy and Ravenswood Turnpike, now the Ravenswood and Spencer, was constructed in 1854. The Guyandotte and Charleston Turnpike, a road running from Charleston by way of St. Albans and through Teays Valley to Guyandotte, was built in 1850. The Gilmore-Ripley and Ohio Turnpike was built in 1852-58.

GENERAL DESCRIPTION.

Jackson County.

Jackson county is the most northern of the three counties described in this report and is bounded on the northwest by the Ohio river for a distance of twenty-seven to twenty-eight miles.

It was formed in March, 1831, from Mason, Kanawha, and Wood counties and named in honor of Andrew Jackson, the Seventh President of the United States. It is bounded and described as follows in the original description:

Beginning at the mouth of Pond creek on the Ohio river, thence a direct line to the west corner of Lewis county where the lines of Lewis county and Kanawha counties meet; thence with the line dividing Lewis and Kanawha counties to a point where the West Fork of the Little Kanawha river crosses said

line; thence a direct line to the Middle Fork of Countze creek, a branch of Pocatalico river; thence a direct line to the mouth of the first branch emptying into the Ohio river above Letart Falls; thence up the Ohio river following its meanders to the place of beginning. A small strip of land on the southwest boundary was added from Mason county to this county in 1867 by the Act of Legislature (See the Act of Legislature in 1867, page 40).

Its area given by districts as carefully computed by the writer from the accurate topographical maps of the United States Geological Survey is as follows:

District.	Square Miles.
Grant	79.69
Ripley	148.05
Ravenswood	92.95
Union	49.53
Washington	100.07
Total	470.29

Ripley is located on Mill creek near the center of the county and is the county-seat.

The county varies in elevation from 525 feet above tide at the Ohio river in the western corner to 1260 feet on top of Garnes' Knob one mile southwest of Kenna, a range in elevation 735 feet. The population in 1900 was was 22.987; whites 22,872, negroes 115, and foreign born 91, and in 1910 it had a total population of 20,956.

The Mean Magnetic Declination in 1900 was 1° 3′. (Bulletin No. 233, Geological Survey, page 72).

The county is a rich agricultural area especially along the Ohio river bottoms and in the creek valleys. The hill lands are rough in places but are well adapted to grazing, fruits and also to agriculture. North of the Big Sandy creek the highest hills are capped with thick limestone of the Dunkard series which has disintegrated for ages and gives considerable fertility to the soil.

The farmers are engaged in raising fruits, fine cattle, fine

horses, sheep and hogs, also wheat, corn, oats, potatoes and tobacco. Some gas and oil are produced in the country, but no coal has yet been mined.

The State Auditor gives the following assessment valuations in Jackson county for the year 1910:

Assessment Valuations.

Real Estate	$4,152,815.00
Personal Property	2,115,310.00
State Tax	2,820.66
Road Tax	626.81

There is no State tax assessed for school purposes. Each district makes its own assessments for the maintenance of schools and the teachers and building funds. There are no large towns located in this county, but there are a great many small towns and places where postoffices were formerly kept, but as the entire county has rural free delivery mail, these country postoffices are more or less eliminated and a large number of the small country stores have been closed. The towns in the county are as follows:

Ravenswood, Ripley, Millwood, Cottageville, Angerona, Evans, Sandyville, Murrayville, Duncan, Fair Plains, Kenna and Gay.

Ravenswood.

Ravenswood, the largest town in Jackson county, is located on the Ohio river at the mouth of Sandy creek, thirty-five miles south of Parkersburg and eighty-five miles north of Huntington. It is situated mainly on the second terrace of the Ohio river, and is therefore above high water. The land where the town is located was once owned by George Washington. The town had a population in 1900 of 1074 and in 1910 of 1081.

There are located here an excellent high school, six churches, a canning factory, fifteen stores, three banks, and two building and loan associations. Situated at the Junction

of the R. S. & G. Railway, it derives a portion of its support from the railways, but the larger portion is derived from the agricultural districts.

Ripley.

Ripley is located on Mill creek near the center of the county and is the county-seat. It is reached by the Ripley and Mill Creek Valley Branch of the Baltimore & Ohio Railway. The town has an excellent high school, five churches, three banks, twenty-two stores, a flouring mill and a planing mill. The town is supported to a great extent by the agricultural district which surrounds it.

Mason County.

Mason county lies west of Jackson and north and west of Putnam county and fronts on the Ohio river for about fifty miles. It is cut into two nearly equal areas by the Kanawha river flowing northwestward across the county. It was formed from Kanawha county by an act of the General Assembly passed in 1804 and was named in honor of the celebrated George Mason, one of the prominent actors in the Revolutionary War (see Lewis' History of Mason county). Its boundary lines are described as follows:

"Beginning ,at the mouth of Little Guyandotte river running thence to the northwest corner of a survey of 1437½ acres made for Thomas Lewis in Teays Valley, near the house of Joshua Morris, from thence to the mouth of Little Hurricane creek, thence crossing Kanawha river and taking the dividing ridge between Eighteen Mile and Pocatalico creeks to the end thereof, thence pursuing a northeast direction to the intersection of the Wood county line to the Ohio river, thence down the Ohio river to the beginning."

The area given by districts as carefully computed from the accurate topographical maps of the United States Geological Survey is as follows:

PLATE IV—Baltimore and Ohio Railroad Bridge Across Kanawha River at Point Pleasant.

District.	Square Miles
Cooper	53.62
Cologne	38.13
Clendennin	85.01
Graham	26.45
Hannan	50.98
Lewis	19.38
Robinson	33.86
Union	54.09
Arbuckle	67.55
Waggener	20.20
Total	449.27

The county varies in elevation from 500 feet above tide at the southwest corner on the Ohio river, to 1070 feet at the top of High Knob near the Putnam county line south of Elmwood, thus having a range in elevation of 570 feet. The population in 1900 was 24,142; whites 23,604, negroes 538, and foreign born 317; and in 1910 it had a total population of 23,019.

The Mean Magnetic Declination in 1900 was 0° 35′. The county is not as well adapted to agriculture as Jackson county, its neighbor on the west, but the bottoms along the Ohio and Kanawha rivers are good agricultural lands and the hills are good for grazing and some farming. The farmers are engaged in raising wheat, corn, oats, potatoes, tobacco, cattle, fine horses, sheep and hogs. It has never produced any oil or gas, but a portion contains coal, and this will be described in a subsequent chapter.

The State Auditor gives the following assessment valuations in Mason county for the year 1910:

Assessment Valuations.

Real Estate	$6,213,414.00
Personal Property	2,658,598.00
State Tax	3,992.41
Road Tax	887.20

The assessed value of the real estate in Mason county is about 50 per cent more than that in Jackson and the personal property is about 40 per cent more than that of Jackson county. No State tax for school purposes is assessed, and each district makes its own assessment for the maintenance of its schools.

There are a number of small towns scattered throughout the county and these are generally well supplied with schools and churches. The towns are as follows:

Point Pleasant, Mason City, Spillman, Hartford City, New Haven, Clifton, Letart, Leon, Glenwood, Upland, Arbuckle, Grim and Ambrosia.

The county has rural free delivery of its mail, thus nearly all the small postoffices are closed, as the farmers now have the daily mail delivered to them in boxes erected along the road side near their residences.

Point Pleasant.

Point Pleasant is located at the confluence of the Kanawha river and the Ohio river and is the county-seat of Mason county. The first settlement made at this point was in 1774 about the time of the battle between the Indians and the Whites which occurred October 10th, 1774.

General Washington was on the site in 1770 accompanied by his physician, Dr. Craig, his friend and surveyor, Colonel William Crawford, and also Joseph Nichelson, Robert Bell, William Harrison, Charles Morgan and David Reuden. They proceeded to locate and survey a large tract of land on the Ohio and Kanawha rivers authorized by military warrants. On the 19th of December, 1794, the General Assembly of Virginia enacted "That the 200 acres of land, the property of Thomas Lewis at the mouth of the Kanawha river, in the said county of Kanawha, as they are already laid off in lots and streets shall be established as the town by the name of Point Pleasant." (Dr. Hale's history of the Great Kanawha Valley).

The records show that Point Pleasant is fourteen years older than Marietta, twelve years older than Charleston, the Capital of the State of West Virginia, fifteen years older than

Cincinnati, seventeen years older than Gallipolis, and twenty-two years older than Chillicothe. It is seventeen years older than Harrodsburg, the oldest town in Kentucky in which State the first log cabin was built in the same year Fort Randolph was reared at Point Pleasant. Thus Point Pleasant is the oldest English town on the banks of the Ohio south of Pittsburg. "It is the Jamestown of the Ohio Valley." (Virgil A. Lewis' history of the Great Kanawha Valley").

Point Pleasant is historical ground, having been the battlefield of a famous contest between the Indians and the whites in October, 1774. In this battle the whites numbered 1,100 and were led by General Andrew Lewis. The Indians were under the leadership of the notorious Indian Chief Cornstalk. The battle was sanguine and long protracted, the issue for some time being doubtful, a success and a repulse alternating between the several factions. The Indians were finally outflanked and put to flight, but not until Colonels Lewis and Fields and seventy-five men were killed and one hundred and forty wounded. (Lewis' history of West Virginia). Cornstalk was afterwards killed and buried here. A monument has been erected to mark the spot. In October, 1909 a monument was unveiled at a point near the confluence of the Kanawha and the Ohio rivers to commemorate this battle, which is now also styled the first battle of the Revolutionary War. A park has been set apart by the people of this portion of the State and christened the "Tu Endie Wei Park."

The population of Point Pleasant in 1900 was 1,934, and in 1910 was 2,045.

Point Pleasant has a good high school, eight churches, three banks, thirty-three stores, a flouring mill, and several other small industries.

Mason City.

Mason City is located on the Ohio river fifteen miles north of Point Pleasant, and had a population in 1900 of 904 and in 1910 of 784. There are several coal mines near this place which will be described in another chapter of this report. It has a good school system, five stores and five churches.

Hartford City.

Hartford City is located twenty-seven miles north of Mason City, and in 1900 had a population of 515, and in 1910 of 358. There are two coal mines near this town, together with two salt works all of which will be taken up later in another chapter of this volume. Hartford City has nine stores, three churches, and a good school system.

Leon.

Leon is located on the north side of the Kanawha river thirteen miles south of Point Pleasant and in 1900 had a population of 250 and 240 in 1910. It has six stores, a flouring mill, a graded school and two churches.

Putnam County.

Putnam county is located south of Mason and Jackson counties and is bounded on the east by Kanawha river and on the west by Cabell and Mason counties. It is divided by the Kanawha river running northwest through the entire length of the county. It was formed from Kanawha, Cabell and Mason counties by an act of the General Assembly passed in 1848, and is bounded as follows:

"Beginning at the mouth of Gallatin's branch where the same flows into the Kanawha river, thence with a straight line (crossing the Kanawha river) to the upper point of the Cedar Cliff, below the great Horse Shoe Bend of Pocatalico river, thence with the dividing ridges between the waters of Kelley's creek and Armour's creek, between Kelly's and the Left Hand fork of Pocatalico, and between the waters of Frog's creek and the Eighteen Mile creek, to a low pag at the head of the main fork of said Frog's creek near a large lick, thence with a straight line to the nearest point in the line of Jackson county, thence with said Jackson line westwardly to the head of the Mud-lick fork of the Thirteen Mile creek, thence with a straight line to the mouth of Eighteen Mile creek on the lower side thereof, thence crossing the Kanawha

river with a straight line to the mouth of the " White Pine Fork' of the Ohio Eighteen Mile creek, thence with a line to a point on the present Guyandotte turnpike, midway between the residence of Thomas Handley and the late residence of Thomas McAllister, deceased, thence to the Tract fork of Mud river, at the mouth of Sycamore, a stream flowing into the Tract fork, thence up the said Tract fork on the northeast side thereof, and binding thereon to James McAllister's, so as to include his farm in the new county, thence with a straight line to the top of Coal Mountain, where the turnpike passes the same, thence along the said mountain and the ridges thereof, as the same divides the waters falling into Coal river from those falling into Scary creek to the point on said mountain where the Old State Road to Kentucky crosses the same, thence with a straight line to the mouth of Gallatin's branch, the place of beginning."

Its area given by districts, as carefully computed by the writer from accurate survey sheets of the United States Geological Survey, is as follows:

District.	Square Miles.
Buffalo	52.53
Curry	71.24
Pocatalico	50.01
Scott	58.54
Teay's Valley	49.67
Union	73 41
Total	355.30

Putnam county had a population in 1900 of 17,330: whites 16,951, negroes 379, and foreign born 107, and in 1910 the total population was 18,587. The Mean Magnetic Declination in 1900 was 1° 15′.

The county has a range in elevation of 513 feet above tide where the Kanawha river leaves this area to 1,232 feet above tide on the highest knob near the southern end of the county, a range in elevation of 700 feet. Putnam county is not so well adapted to agriculture as Mason or Jackson,

owing to the fact that it has not so much river bottom and that the hill land is not so fertile. The farmers produce corn, wheat, oats, potatoes, tobacco and fruit; they also raise fine cattle, sheep, hogs, and horses.

One of the largest fruit farms in this part of the State is located on the Kanawha river just opposite Raymond City. This orchard, owned by the Great Kanawha Orchard Company, contains about 35,000 trees and was planted four years ago.

Putnam county is also rich in gas, oil and coal. However, these will be taken up later in another chapter. The State Auditor gives the following assessed valuations in Putnam county for the year 1910:

Assessment Valuations.

Real Estate	$3,428,220.00
Personal Property	1,591,142.00
State Tax	2,258.71
Road Tax	501.93

The assessed value of real estate in Putnam county is only about half of that in Mason county and the personal property is in about the same ratio; that is, about one-half of that in Mason county. No State tax for school purposes is assessed. Each district makes its own assessments for the maintenance of its schools and building fund.

Putnam county has no large towns or cities, but has a number of small towns scattered over the county as follows: Winfield, Raymond City, Poca, Black Betsey, Plymouth, Buffalo, Hurricane, Liberty, and Upland. The entire county has rural free delivery of the United States mail, so that the inland towns have no post offices and a great many of the former stores in the small villages are now closed.

Winfield.

Winfield is the county seat and is located on the south side of the Kanawha river, thirty-two miles from its mouth.

PLATE V—Birds-eye View of Plymouth, Putnam County

In 1900 it had a population of 338, and 291 in 1910. The town has a good school, four churches, eight stores and a bank.

Raymond City.

Raymond City is located on the Kanawha river at the mouth of Pocatalico river and was named in honor of John I. Raymond, a prominent editor of New York. It is a mining village and its population is not given in the census return for 1910.

In 1865 General Averil, a prominent cavalry officer in the Federal Army came to Raymond City and began operating the mines. He was president of the coal company which afterwards was sold to the Smith Marmet Mining Company and which later became the Raymond City Coal & Mining Company.

Buffalo.

Buffalo is the oldest town on the Kanawha river between Point Pleasant and Charleston. It was settled in 1834 and was incorporated in 1837. It has ten stores, a high school, and three churches. The Buffalo Academy was established in 1849 and flourished until the beginning of the Civil War, when the school building was occupied as barracks by the soldiers of the federal and confederate armies and all the furniture and apparatus were destroyed. It is now used as a school building. Buffalo was named after Buffalo creek which flows into the Kanawha river a few miles south of the town. Its population in 1900 was 364, and in 1910 was 384.

Hurricane.

Hurricane is located in Teays Valley on the Chesapeake & Ohio Railway twenty-six miles west of Charleston. It has a good school system, two churches, a bank, and fourteen stores. It is located in the heart of the tobacco district of Putnam county. In 1909 more than 3,000,000 pounds of tobacco was marketed at this point which brought a sum of $450,000.00.

CHAPTER II.

THE PHYSIOGRAPHY OF THE AREA EMBRACED IN JACKSON, MASON AND PUTNAM COUNTIES

The principles of physiography have been so well set forth by Professor G. P. Grimsley, a former assistant on the West Virginia Geological Survey, in his Detailed County Report on Ohio, Brooke and Hancock that their reproduction here in connection with any discussion of the Ohio river region and that of its tributary streams is very appropriate. The following quotations are from this report in question, pages 18 to 23, inclusive:

"The study of the surface features of the land, the hill and valley, their origin, growth, and final destiny, is one full of interest to all who attempt to read the story locked in the land forms and river valleys. The everlasting hills which have apparently stood unmoved and unaltered during the lifetime of the native resident and his fathers before him, appear to him constant features of this old earth.

"But in a duration of time geologically short, great changes have occurred in these seeming permanent land forms, and rapid changes are taking place today before the eyes of man if only those eyes are trained to see aright and are not blind to the forces of nature. Everything changes and grows old, even these so-called everlasting hills; and all conform to the universal law of nature—adjustment to environment, or to surrounding conditions. This law holds in the inorganic world of rock and cliff, as well as in the world of organisms.

"The engraving tools of frost, heat and sold, rain and running water, are making great waste of land material which is started on its almost ceaseless march, short or long, to the sea, the final resting place for such materials.

"In order more clearly to understand the results of all this work of atmospheric and aqueous agencies, let imagina-

tion picture the growth of a typical land area. The sediments accumulating below the waters of the sea become cemented together and consolidated into rock masses which by earth movements are raised into dry land, a smooth upland plain or plateau with its minor depressions and irregularities. The rains descend upon this land and the water gathers in the depressions and flows off in small rivulets. These small streams flow together and form larger ones and pursue their paths seaward. With increase in volume, the creeks become rivers in deeper channels. The streams follow nearly parallel courses, separated by low divides with lakes in the depressions.

"With the cutting action of the silt laden waters, the channels are carved deeper. The little tributaries are enlarged, cutting backward into the divides until the land area is covered with a branching network of streams like the branches and twigs of a tree. Side by side with the waste of the land through erosion by water, the atmospheric agencies are at work widening the upper portions of the valleys which thereby lose their trench-like character and approach V-shaped valleys.

"As these young streams cut their channels downward, obstructions may be met, a mass of hard rock or other material, and the run or creek bends around it, or the inequality of the original surface may deflect its course, so that the path seaward is not the straight and narrow one, but a winding course. The head of the stream and every tributary are cutting backward in a course more or less irregular, so that the final course of the stream is meandering.

"As the erosive work goes on day and night, year after year, century upon century, the streams on the two sides of the divide approach each other finally cutting away the divide into a series of hills which are further attacked by the tireless energy of water and air until they also are removed wholly or in part. There remains a smooth plain no longer upland, but near the level of the sea, and the land is said to be at base-level, and the cycle is completed from sea plain through upland to coastal plain. This plain is not the level area it was in the beginning of its history, for here and there are the low

hills left between the streams, but it is almost a plain and so has been named a peneplain (pene—almost).

"Earth's forces may again raise the low peneplain to an upland, and the work of erosion begins a second time following the same line of development. According to the studies of geologists, the Appalachian area was apparently brought to a peneplain in Cretaceous time, and re-elevated to be reduced to a second peneplain in the Tertiary period. It was elevated again at the close of that period, and at the present time the work is progressing toward the reduction to a third peneplain.

"The rivers on these plains pass through a cycle of similar development to that of the land forms. By analogy, this cycle is compared with the life history of organisms passing from the period of infancy through adolescence, maturity, to old age and death.

"In the earlier life of the stream as it cuts its way downward, the valley slope is steep. Erosion is rapid through the softer rocks, while the more resistant layers withstand the cutting force and remain for a time as projecting layers over which the water pours in rapids or falls, and the river is in its period of infancy passing into the period of adolescence. The river is now eroding its channel deeper and deeper, and but little from side to side.

"As the valley floor approaches more nearly the level of its outlet, the current becomes less swift, the projecting ledges of the falls are brought to the general grade of the stream. The river can not now cut its channel downward as rapidly as before and it increases the erosion laterally widening the valley. Its load of sediment before carried outward in the swifter current is now dropped in large part and fills the lower part of the channel, spreading out in flood plains. Over these plains the river may take a meandering course, winding from side to side, cutting in one bank and filling on the other. The river now carries its maximum load of sediment and performs its greatest work of erosion, so it is said to be in the maturity of its life.

"When the river valley is graded to a level with the sea, reaching its base level, the current is sluggish or absent, the sediment falls, obstructing the channel, and the river is no

PLATE VI—Teays Valley along C. & O. R. R.

longer able to perform its work. It has reached the period of old age, and settles down to a period of quiescence.

"While the lower portions of a great river may reach this period, its head waters may still be pushing their way backward, cutting into the divides further and further. A single stream may thus be in various periods of the life cycle from source to mouth, a complex river made up of parts. The divides are deeply dissected, and by the more rapid cutting of larger or swifter streams on one side, may migrate toward the weaker streams. If this action goes far enough, the divide may be finally cut through in places, tapping the headwaters of the stream on the opposite side, which may flow through the break and the waters pass to the sea by the way of the faster working stream. The remnants of the old streams still pursuing their former paths are spoken of as **be-headed streams.**

"When the peneplain is raised to the upland with its mature meandering rivers, these will again take up the work of erosion with the activity of a renewed youth and cut the gorges with their inherited winding courses, thus giving a youthful river with many characteristics of the inherited maturity.

"The course of the river and land history as outlined above may be interrupted by forces so far removed from the ordinary that they may almost be called geological accidents. Thus in the Quaternary period of the history of the North American continent, the northern seas were covered with an onward moving ice sheet of great areal extent and thickness. As this mass of ice moved southward across the courses of the rivers, they were often changed in direction and character, bringing still other problems to solve. The wall of ice if thrown across the downward course of river, would pond or dam back the waters causing them to overflow at some low point in the enclosing valley walls. By further erosion of this low point, a new course for the river would be established which might be retained when the ice barrier was removed, or it might then return to its old course.

"With the melting of the large mass of ice, there would be added a silt laden body of water which might overload the

stream far beyond its capacity for waste removal, and then fill up its channel wholly or in part. The river would then follow a new path which might be over the old one or to one side and thus be **super-imposed** on its formed bed. It is this unusual geological force that has greatly altered the river history of the area under consideration in this report. The terminus of the northern glacier was not many miles (10 to 15) north of the northern portion of the Pan Handle, and its indirect effects of floods of water extended far to the south of this area.

"If the map of the Pan Handle is examined with reference to its drainage system, a marked contrast will be noticed between the streams in the northern county and the southern one. Ohio county and southern Brooke are characterized by the irregular branching network of streams, the divides are irregular, and the streams with the exception of the larger creeks have a general southward direction on the longer slopes of the divide, thus conforming to the dip of the rocks.

"In the northern portion of Brooke county and in Hancock, the irregular network is absent, and the streams flow in more nearly parallel paths, but still with the longer branches flowing southward with the dip.

"Further, the larger streams in the whole area show a strong tendency to northwest courses and have a very winding channel. In order to properly understand the river history of the area, it is necessary to pass backward in time to the period before the glacier invasion and attempt to reconstruct from the topographical clues, the pre-glacial drainage.

"America's best glacial geologists have studied this problem, and from their investigations have delineated the courses of the rivers of that far away time. It thus found that the drainage conditions were different. There was no Ohio river flowing southwestward to join the "Father of Waters," though rivers occupied a portion of the valley now drained by the Ohio. Near Moundsville, Leverett found the evidence of a former divide, the waters flowing south from there to about the location of Point Pleasant, then turning northwestward across Ohio in what Professor Tight has named the Marietta river. From the Moundsville divide there flowed northward

the Ohio to near the mouth of the Beaver, where it emptied into a river flowing north to the site of Lake Erie, a river which has been named the Pittsburgh.

"The tributary streams across the Pan Handle had a similar north direction, flowing northwest to join the old Ohio. The terraces of this old river are still visible, especially in the northern part of the Pan Handle and adjacent portions of Ohio and Pennsylvania.

"When the great ice wall crossed the paths of the Pittsburgh and other northward flowing streams, their waters were held back before the ice obstruction, filling their valleys which stood at much higher level than at the present. The waters spread outward on their higher slopes forming some of the higher river terraces. The rivers finally cut their way through low portions of the divide, taking a southern course. The Ohio cut through the divide near Moundsville, joining the Marietta river, whose northern outlet was also cut off, and the present Ohio river came into existence, cutting through the divides further south, probably following closely its present path. The Monongahela tributary of the Pittsburgh river may have cut through near Salem and passed southwestward for a short time. When the ice sheet finally retreated, the Monongahela regained its former course, but the Ohio remained in its new channel.

"In this early history of the Ohio river, the water flowed at a much higher level than now. The present channel has been largely cut down since the glacial period. The old terraces left here and there along its banks mark the elevation of channel in its different stages. These terraces reach 1,000 and 1,050 feet above the sea near Wheeling, while the present river is about 610 feet above the mean tide. At the mouth of the Little Beaver river, opposite the northern edge of the Pan Handle, the terraces are 870 to 965 feet. According to Leverett, the river cut down to the 930 foot level near Wellsburg before the course was reversed to the south. The channel has been cut from 930 feet to 660 feet since the glacial period. There is also evidence that it cut deeper, for the rock floor is about 30 feet below the present river floor, and has been filled

with sediments. There still remain in this area as monuments of this ice invasion the gravel and boulder terraces."

In pre-glacial time the Kanawha river instead of emptying into the Ohio at Point Pleasant, took its course westward near where St. Albans is now located and flowed through the Teays Valley along the line the Chesapeake & Ohio Railway now follows, going by Hurricane, Milton, Barboursville and Huntington. At that time the Ohio river had no existence and the stream formed by the junction of the Kanawha, Guyandotte and Big Sandy rivers flowed northward through the valley where the present Sciota river is now and discharged its waters northward into the Atlantic by way of the St. Lawrence drainage.

The subsequent ponding of these northern flowing streams presumably by the advance of the glacial ice, caused them to overflow and form a new river, the Ohio, along the line of the lowest divides. There is conclusive evidence that this occurred in comparatively late geological time even while this territory had much the same appearance topographically as it has today.

The abandonment of Teays Valley by the Kanawha evidently took place during the time when the Ohio river was in process of formation. After the Kanawha river was diverted from its former course to the present one, Teays Valley was left high and dry with only two important tributaries; viz.; Mud and Guyandotte rivers. The former stream then entered the valley near Milton and followed it to Barboursville, where it united with the Guyandotte and reached the Ohio at Huntington. Mud river has meandered broadly over the wide valley in attempting to adjust itself to the new conditions. Its waters are sluggish, but it has succeeded in removing considerable of the alluvium and is now cutting into the rock floor of the old Kanawha. It is more than probable that the "divide" between the waters that flowed southward into the Kanawha, and those that went northward before this change, was near where Red House is now located and that the Pocatalico river flowed south and emptied into the Kanawha near St. Albans; also that Hurricane creek instead of flowing

north, as it does now, flowed south into the Kanawha and emptied into the same, near where Hurricane is now located.

DESCRIPTION OF THE DRAINAGE BASIN.

Pond Creek.

Pond creek is at the extreme southern boundary of Wood county and runs parallel to the Jackson-Wood county line. It rises on the highest point near Limestone Hill and flowing northwest empties into the Ohio river nar the the Jackson county line. Its length, as measured along its meanders, is about eighteen miles, while in a direct course it would only be eleven miles, the fall from its headwaters to its mouth being 580 feet. Only a few of its branches drain from Jackson county, among which are the following: Little Pond creek, Cabin fork and Pennike run. The channel in the lower half of its length is very meandering.

Little Pond Creek.

Little Pond creek rises in the northern part of Jackson county near Browning and flows northwest, emptying into Pond creek about two miles from its mouth. Its length is about eight miles and its fall from its source to its mouth is 530 feet. There are several small streams running northeast into Little Ponk creek among which are Bailey run, Jessie run, Lamb run, and Bear fork.

Washington Run.

Washington run takes its source near the top of Melhoan Ridge and flows southwest until it reaches the Ohio bottoms and from thence it flows parallel to the Ohio for about one mile and a half before emptying into it. Its entire length from its source to its mouth is four miles. Wheaton run and Skull run are two small branches running into the Ohio north of Sherman.

Little Sandy Creek.

Little Sandy creek flows into the Ohio river at Sherman, running due west a distance of eight miles from its source and has a fall of 550 feet. It has several branches running southwest, among which are the following: Road fork, Clay Lick run, Meeting House fork, and Nigger run. Its greatest fall is in the first two miles from its source.

Sandy Creek.

Sandy creek drains a large portion of Jackson county, running through the entire county. It has its source in Roane county and crosses the Jackson county line at Liverpool. It meanders considerably and reaches the Ohio river at Ravenswood, the distance, by a straight line, from Liverpool to Ravenswood being thirteen miles, and by the railroad a distance of seventeen miles, and by the creek with its meanders, a distance of twenty miles. Its fall from Liverpool to its mouth is about 120 feet.

It has many branches flowing into it both from the north and the south; among them are the following: Lick run, Big run, Straight fork, Wheeler run, Beatty run, Coppen run, Left fork, Island run, Burgess run, Lynn Camp run, Boggess run, Warfield run, WasLer run, Fallen Timber run, Rush run, and Brushy fork. The following streams flow from the south and empty into it: Crooked run, Cherry Camp run, Mud run, Trace fork, Bucket run, Big Lick run, Trace run, Coon run, Hartley run, and Buck run.

Mill Creek.

Mill creek is the largest stream that flows through Jackson county, and it drains its middle portion. It runs across the entire length of Jackson county, having its source in Roane. Its fall in the first fifteen miles is only 60 feet, or about 4 feet to the mile. There are many branches flowing into it, both from the north and the south; among them are the following: Luck run, Falls run, Log Lick run, Mud run, Clay

PLATE VII—Teays Valley, east of Scott, Putnam County.

Lick run, Sycamore creek, Tug fork, Elk fork, Little Mill creek, Cow run, and Parchment creek.

Sycamore Creek.

Sycamore creek empties into Mill creek at Ripley, flowing from the northeast. The distance from its source to its mouth is seven miles and its total fall between its source and its mouth is about 500 feet, its descent in the last four miles being only about 40 feet.

Little Mill Creek.

Little Mill creek together with Elk fork forms Mill creek. It takes its source in Roane county and flows almost due west. Its fall from where it crosses the Jackson-Roane county line to its mouth is 145 feet. Its length, by its meanders, is nine miles.

There are several small streams flowing into Little Mill creek, among which are Station Camp run, Joe's run, Big run, Buffalo creek, and Frozen Camp.

Elk Fork.

Elk fork takes its source in Roane county and flows northwest, forming with Little Mill creek, the main Mill creek. It extends a distance of twelve miles in Jackson county and its fall is 180 feet. The channel meanders considerably, especially near its mouth. Elk fork has several branches among which are the following: Scale run, Welch run, Spruce run, Forked run, Wash run, Billy's run, Brush run, Haw run, Clay Lick run, Baby Hollow, and Wolfe run.

Tug Fork.

Tug fork of Mill creek rises on the boundary line between Roane and Jackson counties and flows northwest, emptying into Mill creek. Its length in the county, including the meanders, is seventeen miles, and its fall, 205 feet. Its channel is

rough and crooked, especially where it cuts through the Waynesburg sandstone.

The famous "Casto Hole" is on this fork. This "hole" was located in one of the rugged cliffs along Tug fork and afforded a hidding place for men who concealed themselves whenever a drafting or recruiting officer of the army was in the county during the Civil War of 1861-65, according to statements as given by the residents of the county.

Tug fork has several branches flowing both north and south, among which are the following: Buffalo run, Grassy run, Straight run, Alum Rock run, Laurel run, Beech run, Upper Big run, Laurel fork, and Grass Lick creek.

Parchment Creek.

Parchment creek takes its source on the high hill near Edgar and flows almost due north, emptying into Mill creek two miles and a half west of Ripley. It has a meandering channel thirteen miles long, and its fall from its source to its mouth is 300 feet.

Parchment creek has several branches, among which are the following: Isaac run, Round Knob, Bull run, Cox's fork, and Grass run.

Little Mill Creek.

Little Mill creek has its source near Chestnut in Mason county and flows in a northeasterly direction, emptying into the Ohio river about one-half mile west of Mill creek. Its entire length is nine miles. Its channel is crooked and its fall about 300 feet. It has several branches, among which is Huff creek, being of the same name as one which flows into the Ohio river.

Broad Creek.

Broad creek takes its source on the divide north of Broad and flows northeast, emptying into the Ohio river at New Haven. Its length is five miles and its fall from its source to its mouth, 300 feet. It has several tributaries, among which are Little Broad creek and Seaman run.

Oldtown Creek.

Oldtown creek rises on the divide two miles east of Letart and flows with a meandering course into the Ohio river two miles and a half north of Point Pleasant. Its total length from its source to its mouth is seventeen miles. It has very little fall for the last fourteen miles.

There are several tributaries flowing into this creek, among which are Potter creek, Robinson run, Trace fork, and Fallen Timber Branch.

Crooked Creek.

Crooked creek empties into the Kanawha river one-fourth mile from its junction with the Ohio. Its channel is very crooked, as its name indicates. The entire length from its source to its mouth is six miles, and its fall, 200 feet.

Willow Branch, One Mile creek, Salt creek, Two Mile creek, Three Mile creek, and Ferry creek are streams flowing into the Ohio river south of Point Pleasant and north of Gallapolis Ferry.

Ohio Sixteen Mile Creek.

Ohio Sixteen Mile creek rises on a divide between the Kanawha and Ohio rivers and flows in a southwesterly direction, emptying into the Ohio river one mile north of Ashton. It has a meandering channel and its entire length, measured with its meanders, is thirteen miles. Its fall from its source to its mouth is 410 feet.

Ohio Eighteen Mile Creek.

Ohio Eighteen Mile creek takes its source on the divide between the Ohio and Kanawha rivers about two miles east of Buffalo in Putnam county and flows almost due west. It empties into the Ohio river one mile and three-fourths north of Glenwood. Its channel is very crooked, its entire length being twelve miles, and its fall, 430 feet. There are several

tributaries which flow into it, among which are Hughes' Branch, Mud run, Road fork, Spring Branch, White Pine creek, Fee Branch, and Rocky fork.

Guyan Creek.

Guyan creek was formerly called Little Guyandotte river, and it flows into the Ohio river one mile and a half southwest of Glenwood. Its mouth is designated as the beginning corner of the boundary line of Mason county. It takes its source on a high divide near Upland, and its entire length is thirteen miles with a fall from its source to its mouth of 400 feet. It has a very crooked channel, especially the last half portion of the creek. There are several tributaries flowing into this creek in Mason county, among which are the following: McCowen Branch, Knife Branch, Bear Hollow, and Bear Hollow creek.

The streams in Mason county, tributary to the Kanawha river, flow into it from both the north and south. Among the streams flowing into it from the south are the following:

Two Mile and Three Mile Creeks.

Two Mile creek and Three Mile creek are two small streams flowing into the Kanawha river two and three miles south of Point Pleasant.

Five Mile Creek.

Five Mile creek rises on a divide between the Ohio and Kanawha and flows in a northerly direction, emptying into the Ohio about four miles east of Point Pleasant. Its entire length is eight miles and its fall from its mouth to its source, 380 feet. It has two branches which are named Little Five Mile and Upper Five Mile creeks.

Nine Mile Creek.

Nine Mile creek takes its source on the divide between the Ohio and Kanawha rivers and is about five miles in length.

with a fall of 390 feet. It flows into the Kanawha river about nine miles southeast of Point Pleasant. It has one important branch known as Upper Nine Mile creek.

Little Sixteen Mile Creek.

Little Sixteen Mile creek empties into the Kanawha river three-fourths of a mile south of Leon. Its entire length is eight miles and its fall from its source to its mouth is 400 feet. Its channel is very meandering, especially the last three miles of its length.

Sixteen Mile Creek.

Sixteen Mile creek takes its source on a divide between the Ohio river and the Kanawha river. Its entire length, measured along its meanders, is ten miles and its fall from its source to its mouth, 430 feet. It has a very meandering channel.

The streams flowing into the Kanawha river in Mason county from the north are the following: Three Mile creek, Rock Castle creek, and Eight Mile creek. These streams empty into the Kanawha river between Point Pleasant and Beech Hill.

Ten Mile Creek.

Ten Mile creek takes its source near Chestnut and flows southwest, emptying into the Kanawha one-half mile southeast of Beech Hill. Its length is eight miles and its fall, 480 feet. It has several tributaries, among which are King branch, Lick fork, and Cooper fork.

Thirteen Mile Creek.

Thirteen Mile creek takes its source in Jackson county and flows almost due west, emptying into the Kanawha river at Leon. Its channel for more than half its length is very meandering. Its entire length measured along its meanders is twenty-six miles, while a straight line from its source to its mouth is not more than half that distance. Its total fall is 500

feet and its fall for the last fifteen miles is only about 90 feet or 6 feet to the mile.

It formerly emptied into the Kanawha river about four miles south of Leon when the latter flowed on a higher elevation.

Arbuckle Creek.

Arbuckle creek flows into the Kanawha river at Grimm's Landing and its entire length is five miles. The drainage of Putnam county is principally into the Kanawha river, but a portion of its southern end drains into Mud and Coal rivers.

Eighteen Mile Creek.

Eighteen Mile creek takes its source in Jackson county near Garnes' Knob and flows almost due west, emptying into the Kanawha river. Its course is very meandering and its entire length, measured along its meanders, from its source to its mouth is thirty miles, while its length measured in a straight line is less than one-half that distance. Its fall from is source to its mouth is 690 feet and the fall for the first five miles from its source is 570 feet, leaving a fall of only 120 feet for the last twenty-five miles, or about 4.8 feet to the mile.

Eighteen Mile creek has several tributaries, among which are the following: Lukes Branch, Bear Branch, Turkey Branch, Spring Valley Branch, Zuig Branch, Bucklew Branch, Jake's Branch, Courtney Branch, Isaac Branch, Dunlap Branch, Dad's Branch, Buffalo creek, Clendennin creek, Right fork, Stump run, Sigman Fork, and Painter Branch.

Little Buffalo Creek.

Little Buffalo creek takes its source on the high divide between Eighteen Mile creek and Kanawha river, emptying into the Kanawha river at Woods. Its channel is very meandering and its entire length is four miles.

PLATE VIII—C. & O. R. R. Cut, east of Scary, showing old river deposits.

Buffalo Creek.

Buffalo creek rises near Confidence and flows almost parallel to the Kanawha river, emptying into the latter at Rumer. It has a very meandering channel, its entire length being ten miles and its fall from its source to its mouth, 470 feet.

Little Guano Creek.

Little Guano creek is a small stream flowing into the Kanawha two miles east of Red House, its length being two miles and a half.

Guano Creek.

Guano creek takes its source on the high divide near Confidence, where Buffalo creek and Buck Lick creeks of Eighteen Mile take their sources, and flows almost due south, emptying into the Kanawha river at Plymouth.

Pocatalico River.

Pocatalico river takes its source in Roane county and flows westward with many meanders, emptying into the Kanawha river at Raymond City. Pocatalico is an Indian name, meaning the "Fat Doe." Its entire length measured with its meanders is seventy-five miles, thirty miles of this length being in Roane county, thirty-four miles in Kanawha, and eleven miles in Putnam county.

It is more than probable that this river once flowed into the Kanawha river at Scary during the time when the latter flowed through Teays Valley. The former course of the river left its present channel at Rocky fork and flowed by way of the Flat Woods and Fry and thence along the course of Armor Branch to Blake creek to the Kanawha river. This old channel was about 150 feet higher than the present one. Left fork, Right fork, and Harmon creek are the only branches of Pocatalico river that drain Putnam county. Middle fork, with its tributaries, and a fork of Pocatalico river drain the southern part of Jackson county.

Five and Twenty Mile Creek.

Five and Twenty Mile creek rises near the Mason-Putman county lines and flows northeast into the Kanawha river two miles south of Buffalo. Its entire length is eight miles and its fall, 360 feet. Its channel is very meandering, especially when it reaches the Kanawha river bottoms, where it flows parallel to the Kanawha river for more than two miles before emptying into same.

Hurricane Creek.

One of the most peculiar creeks in the southern part of the State is Hurricane. It takes its source on Coal Mountain at the Kanawha-Putnam county line about three miles west of the Kanawha river. It flows for eight miles almost due west where it crosses the Teays Valley and thence with a meandering course flows northeast, emptying into the Kanawha river three miles west of Winfield. Its entire length is twenty-five miles and its fall from its source to its mouth is 400 feet, 300 feet of which is in the first eight miles from its source.

There are several tributaries which flow into it, among which are the following: Poplar fork, Poindexter branch, Trace creek, Coon creek, Sleepy creek, Hodges branch, Tacketts branch and Buffs branch. The extreme southern end of Putnam county is drained by tributaries of Mud river which flows to the southwest.

Topography of the Land Area.

The Jackson-Mason-Putnam Area is a high plain or plateau about 1100 to 1200 feet above the sea level. Water erosion has reduced the original plateau or plain practically all to slope land, the streams flowing in deeply cut "V" shaped valleys. Numerous hills and dividing ridges, ranging in elevation from 1,000 to 1,250 feet, capped with layers of harder sandstone and rock strata, being more resistant, remain as the evidence of the original plain or plateau.

Along the western edge, the Ohio river has cut a gorge

in the old plateau or plain from one to two miles in width and from 500 to 600 feet in depth. The valley walls are usually steep, some places almost perpendicular, but on reaching the summit the general surface is rolling except where erosion has been made by creeks and branches. Hard layers of sandstone often cause inequalities in the surface; the softer portions having been eroded away and steep bluffs formed.

The present flood plains of the Ohio and Kanawha rivers are represented by narrow strips of rich bottom land along the shore that widen out first on one bank and then on the other. Also by small islands and bars, among which are Bellville, Buffington, Letart, Eight Mile, and Gallapolis islands. The Kanawha river, bi-secting Mason and Jackson counties, has also cut a deep narrow gorge through the old plain or plateau, and especially is this true in Putnam county near Red House Shoals where the hills are almost perpendicular. This river has abandoned its original course through the Teays Valley and has in a recent geological epoch cut its present channel to the Ohio at Point Pleasant.

The River Terraces.

The Ohio river makes a series of well defined terraces along the Jackson-Mason-Putnam Area. These terraces are long, narrow strips of nearly level land located one above the other, separated by steep bluffs and show as conspicuous topographical features. Ravenswood is built on two of these river terraces, while Mason City and Point Pleasant are built on a single terrace.

The terraces along the Ohio river were first described by Dr. I. C. White in 1878 in Beaver county, Pennsylvania. (See Second Geological Survey of Pennsylvania, Report Q, Page 10). He found five terraces along the river in this county, located as follows:

Fifth terrace____________	820 to 300 feet above river.
Fourth terrace__________	200 to 220 feet above river.
Third terrace___________	120 to 130 feet above river.
Second terrace__________	60 to 80 feet above river.
First terrace____________	30 to 40 feet above river.

The First Terrace represents the flood plain of the river and is composed of coarse and fine sand, fine gravel and clay and includes the various islands and said bars of the streams. These islands have already been named. This terrace forms broad flat bottoms 30 to 40 feet above the river at Willow Grove, Letart, Point Pleasant, and at the mouths of nearly all the streams emptying into the Ohio river. These flood plains are often entirely submerged by the annual spring floods and the soil is greatly enriched thereby, being especially adapted to the raising of corn and potatoes.

The Second Terrace consists of coarser material, such as rounded boulders, rock fragments, coarse gravel mixed more or less with fine sand and gravel, and is often used along the line of the railroad for ballast. This terrace is from 30 to 40 feet above the lower terrace or from 60 to 80 feet above the river. The higher portion of Ravenswood is built on this terrace. This second terrace can also be traced along the different creeks emptying into the Ohio for a considerable distance.

The Third Terrace is composed of fine gravel and sand and is at a distance of 60 to 70 feet above the second terrace. This terrace is also found along some of the streams running into the Ohio.

The Fourth Terrace is from 80 to 100 above the Third Terrace and is found on the plain back of Clifton in Mason county.

The Ohio River.

The Ohio river froms the northwestern boundary of Jackson and Mason counties. Its entire length, as has been determined by the United States Government Engineers, from Pittsburgh, Pennsylvania, to Cairo, Illinois, is 967 miles, and its length along the area under discussion from the mouth of Pond creek to the mouth of Guyan creek is 82 miles.

Prof. G. Frederick Wright has the following to say about this river on page 358, "Ice Age In North America:"

"The Ohio is still the most remarkable of all the rivers in the world for the extent and suddenness of its fluctuations in volume; at one time being so shallow that in places a child

PLATE IX—C. & O. R. R. Cut west of Scary, Putnam County.

can ford it, while at other times it is a raging flood, a mile in width and seventy feet in depth. But, during the time when the ice of the glacial period reached its most southern point of extension, the Ohio above Cincinnati was a slack water stream, six hundred feet in depth, so that a ship could sail 300 feet above the site of Pittsburgh."

Maximum and Minimum River Stages at Wheeling.

The following data on maximum and minimum river stages at Wheeling have been furnished by Mr. Alex. McAshley, local forecaster of the United States Weather Bureau at Pittsburg:

"These observations, extending over a period of 25 years, show the highest record stage of the river at Wheeling 46.5 feet on February 8, 1884; the next highest was 44.6 feet on February 19, 1891. The maximum stages in the different years are found in the months of January, February, March and April, though it has been reached once each in May, June, August and November. The river reached a stage of over 40 feet in six years out of the 25, and over 30 feet in 11 years. The lowest maximum recorded was 1.4 in October, 1892, and it was four feet or under in 21 months of the 25 years.

"The lowest stage of water in the 25 years was 0.3 on August 27, 28, 1893. It was 0.2 September 8, 1894. It has been less than one foot 12 months in the 25 years, and these months were in seven years during August, September, October and November. The highest minimum recorded was 14 feet in February, 1891.

"The average stages during the 25 years show the average maximum stage in March, and the lowest maximum in September. The average minimum stage was in September and the highest minimum in April.

Maximum River Stages at Wheeling, May, 1, 1882, to June 1, 1911.

Maximum River Stages at Wheeling, May 1, 1882, to June 1, 1911.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1882	....	....	....	....	21.2	18.0	15.8	9.3	10.0	9.8	5.7	9.8
1883	17.0	35.5	10.3	22.5	....	....	....	....	....	....	....	....
1884	....	46.5	30.5	17.6	9.8	11.0	10.5	9.8	3.1	5.6	5.8	16.5
1885	32.8	10.8	15.3	24.3	9.3	12.3	7.0	15.9	9.8	11.8	9.6	16.8
1886	29.3	31.0	21.5	32.0	15.0	12.0	6.5	8.3	5.8	6.6	22.0	16.5
1887	24.3	33.8	24.0	14.8	15.5	16.0	4.6	3.2	2.0	....	5.0	5.8
1888	29.8	16.0	19.6	22.0	11.0	8.6	27.1	32.2	11.0	15.5	18.0	16.0
1889	19.0	23.0	17.1	21.0	15.2	28.9	13.6	7.8	4.0	11.0	17.4	19.5
1890	27.8	24.9	32.5	27.2	27.5	10.9	7.0	10.0	24.7	22.9	17.6	14.8
1891	32.9	44.6	19.0	20.9	6.0	15.8	13.0	11.9	7.3	3.0	15.0	17.8
1892	29.0	19.0	23.0	16.0	18.0	23.3	9.5	5.0	3.5	1.4	6.7	11.0
1893	....	32.1	24.8	23.9	31.5	7.0	6.7	4.0	6.9	7.5	9.8	20.5
1894	13.0	22.5	19.3	16.1	28.9	10.9	3.9	2.4	14.0	3.6	7.2	12.5
1895	36.0	7.0	22.2	26.9	6.0	4.1	5.5	3.5	3.3	1.9	9.6	18.5
1896	14.9	19.9	28.4	29.9	9.6	11.3	27.3	22.1	5.0	15.6	11.7	15.9
1897	9.9	37.0	28.0	20.7	18.8	7.9	13.8	7.8	3.0	2.1	13.6	18.9
1898	27.5	21.4	43.9	23.0	16.9	9.9	5.5	17.5	4.4	18.7	21.1	22.8
1899	24.3	20.6	28.2	21.3	22.6	9.8	8.4	6.2	5.9	2.8	7.3	17.7
1900	23.3	25.0	24.9	11.0	6.6	9.5	8.3	6.5	3.0	3.2	34.4	18.0
1901	18.0	8.4	29.0	41.3	25.0	20.5	7.9	7.7	9.0	4.4	14.6	33.9
1902	21.6	17.7	42.0	32.9	8.6	7.9	24.0	11.9	2.6	10.5	11.0	25.6
1903	25.5	34.6	40.2	19.5	8.1	14.7	12.7	11.9	11.7	10.3	16.3	9.9
1904	34.2	26.3	38.5	33.9	18.2	17.0	14.2	5.1	3.4	4.9	3.9	16.4
1905	17.4	17.6	42.9	14.4	14.4	16.3	9.9	13.4	10.7	15.9	12.6	31.6
1906	24.3	8.6	25.9	26.6	9.6	15.4	4.9	15.3	4.7	9.0	18.0	22.9
1907	36.1	16.2	50.1	18.3	15.3	19.0	18.0	10.0	9.3	9.8	16.4	26.0
1908	20.5	42.8	39.6	18.6	26.0	10.9	8.2	4.4	1.0	0.6	0.9	7.1
1909	20.7	33.8	19.9	20.2	33.9	14.0	7.3	6.3	5.5	9.9	8.5	7.7
1910	31.9	23.6	37.5	17.3	11.5	18.9	6.7	1.8	7.0	4.4	9.5	24.5
1911	36.3	34.3	12.5	23.0	10.9							

Minimum River Stages at Wheeling, May 1, 1882, to June 1, 1911.

Minimum River Stages at Wheeling, May 1, 1882, to June 1, 1911.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1882	....	....	....	....	6.2	6.8	3.4	3.2	3.7	3.0	3.2	3.5
1883	4.3	10.0	7.5	10.0	....	....	....	....	....	....	....	....
1884	....	10.2	7.0	6.7	5.5	4.3	2.8	2.6	1.6	1.7	2.5	3.8
1885	5.2	4.8	3.8	9.5	5.3	3.8	2.3	3.3	2.9	1.8	5.7	6.0
1886	6.6	5.5	5.2	5.7	4.8	2.8	2.1	2.3	1.5	1.3	1.5	5.5
1887	5.1	13.3	6.2	5.8	4.6	2.6	1.0	1.3	1.0	....	1.1	2.7
1888	4.1	7.6	7.2	6.1	4.9	1.9	2.8	2.0	3.2	2.6	7.4	7.0
1889	7.4	5.5	6.4	6.5	6.5	7.9	4.4	2.0	0.9	2.6	6.9	8.1
1890	8.6	9.8	8.0	5.9	9.9	5.0	1.8	1.9	4.0	7.0	7.0	3.9
1891	7.0	14.0	9.0	5.5	2.6	4.9	4.0	2.3	1.2	0.9	1.7	6.3
1892	6.3	6.8	6.0	6.4	5.8	5.6	2.7	1.7	1.2	0.9	0.9	5.0
1893	....	8.5	8.4	7.3	7.1	3.0	1.5	0.3	1.2	1.7	2.7	6.9
1894	5.9	6.9	6.9	6.8	4.4	3.2	1.3	1.3	0.2	2.1	3.1	4.5
1895	4.0	3.9	9.3	5.7	3.9	1.7	2.3	1.2	1.3	0.6	0.8	2.9
1896	3.9	5.9	6.7	7.8	3.8	4.3	4.5	3.1	2.3	5.0	4.8	4.2
1897	5.4	9.5	8.9	7.0	4.9	3.6	2.8	3.0	0.9	0.4	0.5	6.2
1898	6.3	5.8	7.0	7.1	7.2	3.7	1.7	4.3	1.5	1.6	5.6	4.9
1899	7.6	5.1	9.7	6.6	5.8	4.0	2.8	1.3	1.0	1.1	1.8	4.0
1900	7.7	4.9	7.7	7.0	3.6	3.3	2.7	1.2	0.3	0.3	1.6	4.9
1901	4.4	4.5	6.3	11.3	6.7	7.3	2.2	1.7	3.2	1.9	1.5	7.2
1902	4.0	4.8	7.9	6.3	4.8	3.8	6.0	2.4	1.1	2.9	2.4	6.8
1903	6.9	7.8	10.0	6.9	2.7	3.4	3.9	2.4	1.8	2.2	2.9	3.0
1904	4.9	4.0	9.3	7.3	5.6	4.9	3.6	1.6	1.3	2.6	1.3	1.4
1905	3.1	4.4	13.4	7.3	4.9	5.0	4.3	4.5	2.8	2.8	5.0	5.9
1906	7.4	4.2	6.1	8.3	4.3	4.1	2.1	2.8	2.7	2.9	4.5	6.0
1907	7.6	7.0	8.1	8.0	8.0	6.3	5.0	2.5	2.9	4.0	5.7	4.1
1908	6.5	6.2	11.7	7.9	8.6	3.9	2.6	1.4	0.0	0.0	0.4	0.8
1909	3.3	4.9	7.2	9.2	4.8	4.2	1.9	1.0	1.3	0.9	2.3	2.2
1910	4.0	6.2	8.2	4.2	5.1	4.9	1.6	0.7	1.0	1.2	3.5	3.6
1911	9.3	8.1	7.3	9.3	3.1	....	....	....	....	....	....	....

The U. S. Engineer's Office at Wheeling gives the following stages for high and low water at that place for the years 1907 and 1908:

	High Water Feet.		Low Water Feet.
Jan. 20, 1907	37.0	August 19-20, 1907	2.8
Mar. 15, 1907	50.1	Sept. 20-Oct. 9, 1908	0.0
Feb. 16, 1908	42.8		
March 20, 1908	39.6		

Ohio River Flood Records.

The following table of Ohio river flood records is often given, but the authority for the figures is not known to the writer, and they do not agree exactly with the records given above:

Date.	Pittsburg.	Wheeling.	Diff.
November 10, 1810	32.0	48.0	16.0
February 10, 1832	35.0	48.1	13.1
April 20, 1852	31.9	48.0	16.1
April 13, 1860	26.7	43.0	15.5
September 30, 1861	30.0	44.2	14.2
April 23, 1862	27.9	37.0	9.1
March 19, 1865	31.4	41.0	9.6
December 15, 1873	25.6	40.8	15.2
January 9, 1874	22.4	38.8	16.4
December 12, 1878	24.9	34.9	10.0
June 21, 1881	25.6	40.9	15.3
February 19, 1883	25.8	39.7	13.9
February 7, 1884	33.6	52.4	18.8
February 18, 1891	31.3	44.1	13.8
January 8, 1895	25.9	36.2	10.5
February 24, 1897	24.5	37.1	12.2
March 24, 1898	28.5	44.6	16.1
April 22, 1901	28.0	41.9	13.9
March 2, 1902	32.4	43.3	10.9
March 2, 1903	29.0	40.3	11.3
January 24, 1904	30.1	44.2	14.1
March 4, 1904	29.1	39.3	10.2
March 22, 1905	28.8	42.7	13.9

Maximum and Minimum River Stages at Parkersburg.

The following data on maximum and minimum river stages at Parkersburg have been furnished by Mr. H. C. Howe, section director of the United States Weather Bureau, at Parkersburg.

These records for a period of 21 years show the highest

stage of the river in this time to be 47.8 feet in March, 1898. In January, 1903, a stage of 44 feet was recorded and 44.6 feet in February, 1891. The lowest stage reached during the 21 years was 0.3 foot in October, 1908.

Maximum River Stages at Parkersburg, July 1, 1888, to June 1, 1911.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1888	....	....	....	....	....	....	24.0	28.5	12.5	15.2	17.8	14.7
1889	20.2	22.2	17.9	19.6	14.0	23.8	12.8	8.5	4.4	9.7	19.5	20.0
1890	29.0	26.2	35.0	26.6	28.9	16.2	13.3	13.2	27.2	23.2	18.7	16.2
1891	34.5	44.6	21.9	24.8	11.0	16.0	12.8	13.9	7.3	4.0	14.6	17.8
1892	27.0	19.3	21.7	17.6	19.0	21.8	9.9	7.0	5.0	2.3	6.2	11.0
1893	18.0	38.0	26.1	24.4	31.0	9.5	7.8	3.6	6.0	8.2	7.3	20.0
1894	12.9	24.0	18.7	16.1	25.9	11.0	4.0	1.2	12.4	3.5	7.4	12.0
1895	37.0	8.3	23.9	23.5	7.0	3.8	5.3	3.0	1.7	1.7	9.7	19.0
1896	15.6	21.2	25.5	30.0	10.7	14.2	33.2	27.2	7.1	16.8	15.2	15.6
1897	10.5	37.5	30.3	21.8	18.7	9.0	13.5	8.8	3.6	2.6	10.3	18.0
1898	31.0	22.1	47.8	26.2	18.9	9.5	7.0	16.9	6.5	17.5	20.8	23.5
1899	26.6	20.9	29.0	26.9	20.0	11.8	8.8	7.0	6.8	3.1	7.8	17.2
1900	22.2	25.3	25.2	11.8	7.0	8.7	8.9	7.5	4.8	4.0	30.0	20.8
1901	17.8	9.5	29.0	43.7	25.0	22.8	7.6	7.0	9.0	5.0	14.0	28.8
1902	23.8	17.0	40.0	34.2	9.0	9.2	23.0	11.0	3.5	9.8	11.8	29.0
1903	44.0	35.0	39.4	27.0	8.5	13.4	11.5	11.3	10.8	11.0	14.9	9.4
1904	42.0	24.5	38.6	34.8	23.4	18.1	15.5	4.8	4.3	5.2	4.5	15.0
1905	17.0	9.8	42.4	15.0	19.9	16.8	9.4	12.4	10.5	15.0	16.0	29.8
1906	22.9	9.8	30.1	30.0	11.3	14.8	7.7	14.0	6.3	9.3	18.8	21.1
1907	40.1	16.9	51.6	20.8	15.4	18.6	21.6	9.9	11.2	10.2	15.2	25.3
1908	19.0	41.2	38.6	23.1	28.8	11.3	8.7	7.2	1.5	0.3	0.5	7.7
1909	20.4	37.2	27.6	21.9	34.2	15.0	10.0	8.7	4.0	9.6	6.0	8.7
1910	35.1	20.6	42.0	16.6	13.0	17.0	7.6	2.3	7.2	6.3	9.2	17.2
1911	36.0	36.3	12.8	24.0	11.3	....	....	....	....	....	....	....

Minimum River Stages at Parkersburg, July 1, 1888, to June 1, 1911.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1888	....	....	....	....	....	....	3.9	2.9	4.0	3.7	7.8	6.2
1889	7.9	6.0	6.5	6.9	5.8	7.6	6.0	2.9	1.7	2.9	8.1	8.5
1890	8.9	11.5	8.4	6.8	11.0	6.0	2.8	2.7	4.9	6.9	7.4	6.2
1891	9.2	16.0	10.4	6.0	3.8	5.7	5.2	4.4	2.2	1.8	2.7	8.0
1892	6.6	6.0	7.6	8.4	7.0	6.9	4.3	2.7	1.9	1.0	0.8	5.4
1893	4.9	10.5	9.5	8.2	8.0	4.6	2.1	0.5	0.7	1.2	2.8	6.9
1894	8.0	8.6	9.5	8.0	5.6	3.6	0.6	0.6	0.3	0.7	1.8	5.0
1895	4.4	6.5	9.3	6.5	4.0	0.8	2.2	1.0	1.0	0.7	0.5	3.1
1896	5.1	7.4	8.5	9.5	5.0	6.1	6.0	4.5	3.1	6.9	6.0	5.8
1897	6.8	8.3	11.0	8.0	6.4	5.0	5.0	4.2	1.4	0.9	0.9	7.7
1898	8.3	8.0	8.1	8.5	8.4	5.2	2.8	6.2	2.5	2.3	7.0	7.1
1899	8.9	6.0	10.7	8.2	7.0	6.0	4.2	1.9	1.9	1.5	2.2	5.1
1900	4.3	7.8	9.8	7.4	4.7	4.6	4.6	2.1	1.2	0.8	2.3	5.2
1901	3.5	4.8	4.4	12.0	7.4	8.3	2.8	1.9	4.3	2.0	1.9	8.0
1902	5.2	3.4	8.0	7.3	5.8	3.8	7.8	3.0	1.9	2.7	2.9	8.0
1903	7.8	10.0	10.6	8.0	3.5	5.6	5.4	2.8	3.4	2.6	3.3	3.2
1904	5.4	6.6	9.6	7.4	6.5	6.0	4.8	2.7	1.7	1.8	1.7	1.6
1905	6.3	6.0	9.0	8.0	6.5	6.3	5.6	5.4	3.0	3.8	6.2	7.4
1906	9.0	5.6	8.5	9.0	5.2	5.5	2.7	3.2	3.0	3.2	5.3	7.2
1907	8.5	8.3	9.6	8.8	9.0	7.5	7.2	3.8	4.2	4.5	7.0	5.4
1908	8.0	8.0	12.0	9.0	9.4	4.7	3.4	1.6	0.2	0.3	0.2	0.6
1909	3.7	7.6	9.0	10.0	7.3	7.5	2.9	2.4	1.7	1.5	2.5	2.9
1910	3.6	8.0	9.0	5.4	7.5	6.1	2.3	0.5	0.7	2.1	4.4	3.8
1911	10.4	9.5	9.6	10.5	4.4	....	....	....	....	....	....	....

The following data are compiled from the records of the United States Weather Bureau from July, 1888, to June 1, 1911:

Ohio River Flood Records at Parkersburg.
(Flood Stage at Parkersburg, 36 Feet).

	Day of month.	Stage.
1832 February	16	49.5
1852 April	20	44.0
1860 April	16	44.7
1861 September	30	45.1
1862 April	23	37.0
1873 December	15	38.7
1874 January	9	38.8
1881 February	21	40.0
1883 February	19	45.2
1884 February	7	52.9
1891 February	21	44.8
1893 February	11	38.0
1895 January	11	37.0
1898 March	26	48.2
1901 April	23	43.9
1902 March	4	40.0
1903 March	3	39.9
1904 January	26	42.4
1904 March	5	39.3
1905 March	23	42.4
1907 January	21	40.1
1907 March	16	51.6
1908 February	18	41.2
1908 March	21	38.6
1909 February	27	37.2
1910 March	4	42.0
1911 February	1	36.3

The following tables show the High Water Gauge readings on the New and Kanawha rivers, time consumed by Crest of rises in traveling from point to point, and Rainfall, taken from Records kept at U. S. Engineer's Office, Charleston, W. Va.

Comparative table of some high water gauge readings at Radford, Hinton, Kanawha Falls and Charleston, with date and hour that water attained its highest point.

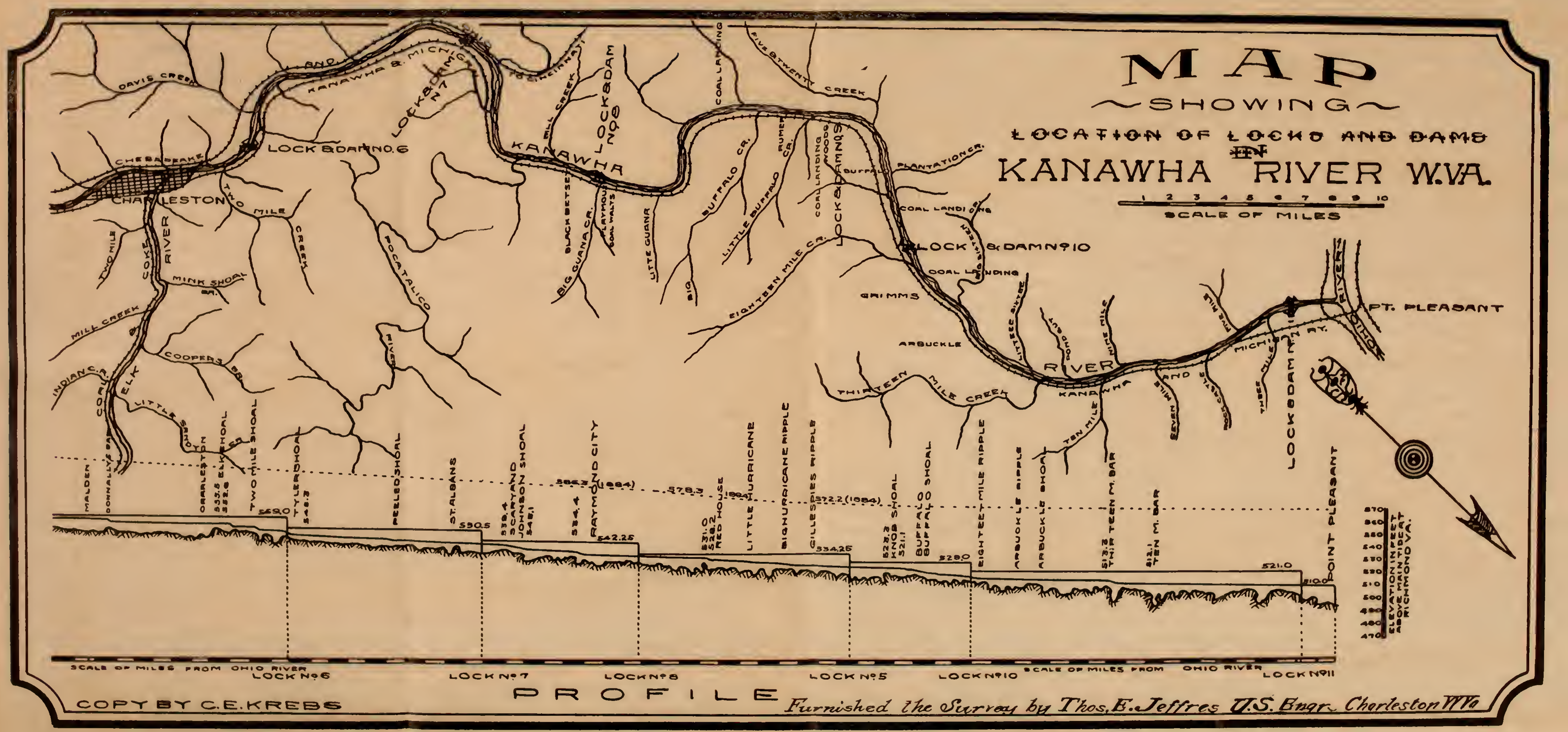
Month and Year	LOCATION OF GAUGE											
	Radford			Hinton			Kanawha Falls			Charleston		
	D	Hour	Gauge Ft.	D	Hour	Gauge Ft.	D	Hour	Gauge Ft.	D	Hour	Gauge Ft.
Sept. 1861	..	....	....	..	.....	....	..	....	....	29	....	46.872
Feb. 1875	..	....	....	..	.....	....	..	....	....	26	6:00 p.m.	36.10
Aug. 1875	..	....	....	..	.....	....	..	....	....	3	night.....	33.30
Jan. 1877	..	....	....	..	.....	....	..	....	....	16	8:00 p.m.	35.70
Nov. 1877	..	....	....	..	.....	....	..	....	....	25	1:30 p.m.	35.10
Sept. 1878	13	....	34.0	13	.....	20.2	14	3:00a.m.	37.8	14	2:00 p.m.	41.632
Jan. 1879	..	....	....	..	.....	....	..	....	....	14	2:00 a.m.	36.67
Apr. 1886	..	....	....	1	4a.m.	16.4	1	12:30p.m.	30.0	1	6:00 p.m.	39.35
Apr. 1886	..	....	....	6	9p.m.	14.1	..	....	....	7	2:00 a.m.	36.25
June, 1889	..	....	....	1	4a.m.	13.0	1	....	24.8	1	3:00 p.m.	30.90
Mar. 1890	..	....	....	23	9p.m.	7.5	..	....	....	23	8:00 p.m.	30.95
Feb. 1893	..	....	....	18	8a.m.	10.5	18	12:30a.m.	20.0	18	12:00 m.	29.95
July 1896	9	....	14.5	9	5p.m.	12.4	10	2:00a.m.	19.4	10	12:00 m.	20.20
Feb. 1897	22	....	11.5	23	9p.m.	14.8	23	8:00a.m.	28.5	23	10:00 p.m.	41.40
Mar. 1899	..	....	....	5	6a.m.	14.0	5	12:00 m.	30.6	5	9:00 p.m.	41.25
Mar. 1899	19	....	10.3	20	9a.m.	10.5	20	1:00p.m.	17.2	20	10:00 p.m.	20.65
Oct. 1900	24	6:00 a.m.	27.0	24	3p.m.	12.5	24	10:00p.m.	18.9	25	7:00 a.m.	17.80
Nov. 1900	26	12 00 m.	9.0	26	9p.m.	13.5	26	10:00p.m.	24.6	27	8:00 a.m.	31.00
April 1901	3	6:00 p.m.	12.0	4	1a.m.	11.1	4	7:00a.m.	18.7	4	2:00 p.m.	27.50
April 1901	20	5:30 p.m.	25.0	21	4a-m.	18.0	21	7:45a.m.	30.0	21	7:00 p.m.	36.40
May 1901	22	3:30 p.m.	26.4	22	9p.m.	18.8	23	1:00p.m.	34.5	23	1:30 p.m.	38.50
June 1901	..	....	....	17	6p.m.	9.9	17	12:00p.m.	15.1	18	9:00 a.m.	17.10
June 1901	23	8:00 a.m.	8.4	23	6p.m.	11.2	23	9:00p.m.	22.1	24	3:00 a.m.	31.45
Aug. 1901	6	9:00 p.m.	20.1	7	7a.m.	12.5	7	2:00p.m.	18.0	7	12:00 m.	18.00

Data for Information Concerning Locks and Dams in KANAWHA RIVER, W. VA.
(Furnished the Survey by Thos. E. Jeffers, U. S. Engineer, Charleston, W. Va.)

LOCKS. DAMS.

No. of Lock.	Miles from mouth.	1879 Low water.	Clear Width.	Available length.	Length over all.	Length between quoins.	Tide reference. Miter sill.	Tide reference. Top of wall.	Style	Length of pass.	Length of Weir.	Height of pass trestle.	Length of wickets. Pass.	Length of wickets. Weir.	Tide reference Pass sill.	Tide reference Weir sill.	Tide reference Upper pool.	Normal Lift.	When finished.
			Feet.	Feet.	Feet.	Feet.				Feet.	Feet.	Ft. In.	Ft. In.	Ft. In.				Ft.	
2.	84½	585.46	50	271	377	308	578.75	609.75	Fixed	...	...	.. ...	.. ...	.. ....	.....	.....	597.75	10.33	1887
3.	79½	571.32	50	272	381	312	566.75	596.75	"	...	...	.. ...	.. ...	.. ...	.....	.....	587.42	13.67	1882
4.	73¼	564.44	50	274	365	300	559.75	579.75	Movable	218	210	16 2¼	13 9	6 3½	561	567.75	573.75	7.25	1880
5.	67¼	556.22	50	274	365	300	552.50	572.50	"	250	265.5	17 ½	13 10	5 3	553.50	561.50	566.50	7.50	1880
6.	54	548.64	55	313	410.5	342	543.75	565.50	"	248	310	16 8½	13 5½	7 7	546.50	552	559	8.50	1886
7.	44	539.63	55	313	411	342	535.50	555.50	"	218	316	16 9¾	14 ⅛	9 2 5-32	537.50	542	550.50	8.25	1893
8.	36	531.27	55	313	411	342	526	547.25	"	248	292	16 9¾	14 ⅛	9 2 5-32	529.25	533.75	542.25	8	1893
9.	25¼	523.64	55	313	411	342	520.50	539.50	"	218	281	16 9¾	14 ⅛	9 2 5-32	521.25	525.75	534.25	6.25	1898
10.	19	517.41	55	313	411	342	514	533	"	248	284	16 9¾	14 ⅛	9 2 5-32	515	519.50	528	7	1898
11.	1¾	510.08	55	313	411	342	504	526	"	304	364	16 9¾	14 ⅛	9 2 5-32	508	512.50	521	10.92	1898

Note: Upper miter sill: Lock No. 2=589.75; Lock No. 3=576.75. Top of wall at head of Lock No. 3=601.25.
Elevations are 3.855 Lower than U. S. Geological Survey.



1. Sketch showing location of locks and dams on Kanawha River.

The following table shows the time consumed by crest of rise (Highest Point) in traveling between different points from Radford, Virginia, to Charleston, West Virginia.

Month and Year	Radford to Hinton	Radford to Kanawha Falls	Radford to Charleston	Hinton to Kanawha Falls	Hinton to Charleston	Kanawha Falls to Charleston
Sep. 1878..						11 hrs.
Apr. 1886..				8½ hrs.	14 hrs.	5½ hrs.
Feb. 1893..						11½ hrs.
July 1896..				9 hrs.	19 hrs.	10 hrs.
Mar. 1899..				6 hrs.	15 hrs.	9 hrs.
Mar. 1899..				4 hrs.	13 hrs.	9 hrs.
Oct. 1900..	9 hrs.	16 hrs.	25 hrs.	7 hrs.	16 hrs.	9 hrs.
Nov. 1900..	9 hrs.	10 hrs.	20 hrs.	1 hr.	11 hrs.	10 hrs.
Apr. 1901..	7 hrs.	13 hrs.	20 hrs.	6 hrs.	13 hrs.	7 hrs.
Apr. 1901..	10½ hrs.	14¼ hrs.	25½ hrs.	3¾ hrs.	15 hrs.	11¼ hrs.
May 1901..	5½ hrs.	9½ hrs.	22 hrs.	4 hrs.	16½ hrs.	12½ hrs.
June 1901..				6 hrs.	15 hrs.	9 hrs.
June 1901..	110 hrs.	13 hrs.	19 hrs.	3 hrs.	9 hrs.	6 hrs.
Aug. 1901..	10 hrs.	17 hrs.	27 hrs.	7 hrs.	17 hrs.	10 hrs.

Gauley River ran out ahead of New River.

The following table shows the number of days in each month the Kanawha river stood at or above the different even-foot gauge readings at Charleston, West Virginia. The average is taken for sixteen years (July 1, 1873, to July 1, 1889) and represents the available water for open river navigation at and below Charleston.

Days and Hundredths of Days. (Gage reading in feet.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1 ...	31.00	28.25	31.00	30.00	31.00	30.00	30.43	29.62	24.87	27.31	28.18	31.00
2 ...	30.75	28.25	31.00	30.00	31.00	30.00	27.44	21.81	19.56	20.75	25.63	29.88
3 ...	30.56	28.25	31.00	30.00	30.87	27.31	20.19	17.56	12.50	14.44	19.75	28.88
4 ...	29.13	27.50	30.75	30.00	28.44	21.00	13.06	11.25	8.75	7.38	15.75	25.94
5 ...	25.31	24.81	29.06	27.69	21.44	14.63	7.88	5.94	6.06	4.25	11.81	17.50
6 ...	20.19	20.31	23.13	21.19	15.31	8.19	5.25	3.69	3.81	2.50	6.94	12.00
7 ...	14.75	14.56	14.31	14.75	9.06	3.88	3.63	2.50	2.56	1.56	4.56	8.81
8 ...	10.94	10.19	11.00	9.44	5.37	2.31	2.63	1.38	1.88	1.00	2.69	5.88
9 ...	8.06	8.06	7.00	6.50	3.19	1.44	1.81	1.06	1.56	0.88	1.94	3.91
10 ...	6.13	6.56	5.56	4.75	2.31	1.00	1.31	0.88	1.13	0.63	1.31	2.88
11 ...	5.19	5.69	4.06	3.88	1.87	0.81	0.94	0.63	1.06	0.50	1.00	1.75
12 ...	4.38	4.69	2.94	3.25	1.31	0.56	0.88	0.63	0.75	0.44	0.75	1.44
13 ...	3.75	4.25	2.31	2.56	1.00	0.38	0.63	0.50	0.75	0.38	0.56	1.00
14 ...	2.88	3.69	1.81	2.31	0.75	0.25	0.63	0.38	0.69	0.19	0.38	0.88
15 ...	2.19	3.38	1.56	2.13	0.56	0.19	0.44	0.38	0.69	0.13	0.25	0.50
16 ...	2.06	3.00	1.38	2.00	0.38	0.13	0.31	0.31	0.56	0.13	0.25	0.44
17 ...	1.75	2.50	1.06	1.63	0.38	0.13	0.25	0.25	0.38	0.13	0.19	0.31
18 ...	1.63	2.13	0.81	1.44	0.25	0.13	0.19	0.25	0.38	0.13	0.19	0.25
19 ...	1.38	1.88	0.69	1.25	0.06	0.13	0.19	0.19	0.31	.....	0.19	0.25
20 ...	0.88	1.63	0.63	1.13	0.06	0.13	0.19	0.13	0.25	.....	0.19	0.13
21 ...	0.69	1.31	0.50	0.94	0.06	0.13	0.13	0.13	0.19	.....	0.19	0.13
22 ...	0.56	1.00	0.31	0.94	0.06	0.13	0.13	0.13	0.19	.....	0.13	0.13
23 ...	0.50	0.88	0.25	0.81	.....	0.13	0.06	0.13	0.13	.....	0.13	0.13
24 ...	0.50	0.69	0.06	0.69	.....	0.13	0.06	0.13	0.13	.....	0.13	0.13
25 ...	0.38	0.56	0.06	0.56	.....	0.06	.....	0.13	0.13	.....	0.13	0.06
26 ...	0.38	0.50	0.06	0.44	.....	0.06	.....	0.13	0.13	.....	0.13	0.06
27 ...	0.38	0.38	.....	0.44	.....	0.06	.....	0.13	0.13	.....	0.06	.....
28 ...	0.31	0.25	.....	0.38	.....	.....	.....	0.13	0.13	.....	0.06	.....
29 ...	0.25	0.19	.....	0.38	.....	.....	.....	0.13	0.13	.....	0.06	.....
30 ...	0.25	0.13	.....	0.31	.....	.....	.....	0.13	0.13	.....	0.06	.....
31 ...	0.25	0.13	.....	0.31	.....	.....	.....	0.06	0.06	.....	0.06	.....
32 ...	0.25	0.06	.....	0.19	.....	.....	.....	0.06	0.06	.....	0.06	.....
33 ...	0.25	0.06	.....	0.19	.....	.....	.....	0.06	0.06	.....	0.06	.....
34 ...	0.19	0.06	.....	0.19	.....	.....	.....	.....	0.06	.....	0.06	.....
35 ...	0.19	0.06	.....	0.19	.....	.....	.....	.....	0.06	.....	0.06	.....
36 ...	0.12	0.06	.....	0.06	.....	.....	.....	.....	0.06	.....	.....	.....
37 ...	.....	.....	.....	0.06	.....	.....	.....	.....	0.06	.....	.....	.....
38 ...	.....	.....	.....	0.06	.....	.....	.....	.....	0.06	.....	.....	.....
39 ...	.....	.....	.....	0.06	.....	.....	.....	.....	0.06	.....	.....	.....
40 ...	.....	.....	.....	.....	.....	.....	.....	.....	0.06	.....	.....	.....
41 ...	.....	.....	.....	.....	.....	.....	.....	.....	0.06	.....	.....	.....

Highest known rise was 46.87 feet in September, 1861.

Rainfall at Charleston, West Va., for 26 Years, 1885-1910.

INCHES.

	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1885	5.12	2.12	1.57	2.84	2.38	2.49	4.13	4.61	1.25	5.30	2.08	1.61	35.50
1886	2.86	2.49	4.10	3.25	5.51	6.90	2.38	3.57	5.13	0.91	4.32	2.78	44.20
1887	1.88	8.10	2.69	4.60	2.13	3.31	2.20	4.96	2.96	0.61	1.16	1.73	36.33
1888	3.55	3.25	4.28	1.97	3.72	1.40	3.88	4.64	6.29	6.30	2.69	1.67	43.64
1889	3.53	2.13	1.97	2.23	6.49	7.19	6.31	1.87	5.69	3.12	5.37	1.60	47.50
1890	3.55	6.86	8.94	4.48	6.94	2.86	2.93	9.05	3.08	3.14	2.00	5.40	59.23
1891	4.38	5.47	4.55	2.31	4.84	7.74	3.79	6.16	1.23	1.94	3.25	2.83	48.49
1892	3.62	2.08	4.52	4.99	4.96	2.74	4.08	4.27	1.59	0.59	3.75	3.59	40.78
1893	2.56	4.43	1.60	3.54	2.95	4.29	4.08	4.27	1.59	0.59	3.75	3.59	40.49
1894	2.32	5.00	2.09	3.16	3.88	2.82	0.42	1.56	4.00	1.16	2.50	3.91	32.82
1895	5.15	0.73	4.24	2.60	2.08	2.04	4.43	5.68	1.16	1.20	1.85	2.62	33.78
1896	1.00	4.01	7.10	2.67	4.24	4.81	5.11	4.74	3.84	2.62	3.68	1.68	45.50
1897	1.20	5.62	3.13	2.74	4.63	6.34	4.00	3.10	0.48	0.00	3.79	4.10	39.13
1898	6.15	2.23	7.20	2.16	3.17	3.10	5.45	7.53	3.72	4.30	2.66	2.42	50.09
1899	7.34	4.20	8.49	1.49	4.05	5.40	5.39	4.54	3.40	0.86	1.75	2.06	48.97
1900	1.31	3.35	3.15	0.96	2.78	7.09	3.80	2.88	0.66	1.80	6.58	1.89	36.25
1901	1.49	0.72	2.91	6.47	5.11	6.86	1.94	5.23	3.43	0.38	1.50	7.28	43.32
1902	4.25	4.04	3.66	1.86	1.96	6.52	4.90	1.30	3.04	1.74	3.56	5.69	42.52
1903	1.82	7.99	4.10	5.46	1.84	3.48	2.52	1.44	0.28	1.70	2.16	2.19	34.98
1904	2.19	2.63	3.54	4.08	2.72	2.69	3.28	3.45	1.51	1.65	0.45	2.65	30.84
1905	3.28	2.94	4.81	3.33	5.69	5.05	4.56	3.82	1.06	5.31	2.17	2.96	44.98
1906	3.31	1.65	5.37	1.96	2.25	5.76	5.59	2.51	3.62	1.60	1.97	4.77	40.36
1907	5.02	4.31	3.72	3.59	3.66	6.27	5.31	7.12	2.59	3.10	3.91	2.37	50.97
1908	2.16	3.71	7.10	7.15	4.50	2.50	4.25	1.94	0.40	1.24	1.53	3.29	39.77
1909	2.74	4.04	4.98	4.88	4.42	5.88	5.60	3.66	4.10	1.83	2.39	1.27	45.79
1910	5.05	3.09	0.66	3.37	4.93	8.61	5.18	0.78	4.88	1.62	2.13	3.06	44.36
Average	3.35	3.74	4.25	3.40	3.92	4.77	4.06	4.03	2.73	2.10	2.81	3.04	42.20

PART II.

The Geology of the Jackson-Mason-Putnam Area

CHAPTER III.

GEOLOGICAL STRUCTURE

Introduction.

The structure or lay of the beds of the different formations in the Jackson-Mason-Putnam Area is very simple. The rocks are slightly bent into a few parallel wrinkles or folds, having a general direction of northeast and southwest courses. In the description of these folds the upper bending arch is called an **anticline** and the downward bending a **syncline.** The **axis** of any fold is the line joining the highest points of any anticline or the lowest points of any syncline, and from which the strata dip in an anticline and to which they dip in a syncline. The **strike** is the direction of the horizontal edge of dip beds and is frequently, although not always, parallel to the axis of a fold, diverging from it when the axis is not horizontal. The sudden fall of the axis of an anticline forms what is called a **nose** of the fold. The original position of rock beds of any sedimentary formation is horizontal. These deposits, however, may take on a slope of considerable pitch. Earth movements cause modification of this original position and produce the above described structural forms generally used in geology.

Method of Representing Structure.

There are two methods that can be used in representing geological structure. One of these is by cross sections which show the strata as they would appear if a deep canal or sec-

tion were dug across the entire area under discussion. This method can be used where the dip of the rocks is very heavy and is perceptible to the eye, but in the Jackson-Putnam Area it would not be practical nor satisfactory without greatly exagerating the vertical scale of the cross section in comparison to the horizontal scale; also this method would only give an idea of the structure along certain lines and would not give the slope of the arches or basins. This is of great value in the commercial development of the area, for both future mining of the coal and the exploitations of the oil and gas territory.

The method of representing the structure which has been used by the U. S. Geological Survey in the bituminous coal fields of Western Pennsplvania and has been adopted by Ray V. Hennen, Assistant Geologist of West Virginia, in his report of the Marshall-Wetzel-Tyler Area, consists in the representation by contour lines of the position of some bed stratum. This stratum is generally the one that is known throughout the area by its wide exposures in the outcrop, its relation to some other bed above or below it, or its wide use as a key-rock by the drillers for oil and gas. These contour lines show in a general way the form and the size of the folds into which the key-stratum has been distorted and its altitude above the level of the sea at all points.

In the area under discussion, the writer has taken the bottom of the Pittsburgh-Pomeroy sandstone or the top of the Pittsburgh coal bed as a key-rock. This is the most widely known and the best identified stratum and is the one used as a key-rock for drillers for oil and gas over the three counties under discussion, to determine the position of the lower oil and gas bearing sands. In Jackson county this coal seam lies principally deep below the surface and quite frequently is not present; but the heavy sandstone (the Pittsburgh-Pomeroy) is a hard conglomerate formation and can be readily determined in the scattering wells in this barren area; also the interval of the top of the coal above the "Big Injun sand" was used in several wells to determine the position when not otherwise found. Its known position below the Washington coal was used in many instances in order to determine its location where no other way was available.

PLATE X—C. & O. R. R. Cut near Scary, Showing Rounded Boulder Deposits, 150 feet above Kanawha River.

The roof portion instead of the floor or bottom of the seam was taken by the writer as a datum under which to represent the geological structure of the area for the reason that the records of the wells drilled for oil and gas on which the levels were taken show only the depth to the bottom of the hard sandstone or top of the seam of coal and do not report the thickness of the coal seam.

The altitude of the Pittsburgh coal seam has been determined from its elevation at the different points of its outcrop in the area; also from the records of core drill holes and the well records drilled for oil and gas throughout the area by taking levels on the surface and then determining the altitude of the coal from their records. After the elevation of the Pittsburg coal has been determined in many places, points of equal elevation are connected by contour lines. For illustration, all points having an elevation of 600 feet above mean tide are connected by a line which will then become the 600 foot contour line. In the same manner all points having an elevation of 575 feet are connected by 575 foot contour lines and so on. Contour lines as drawn show a vertical distance of 25 feet throughout the entire area. These lines are printed on the structural. and economical map accompanying this report in a separate case, and show not only the approximate elevation of the top of the Pittsburgh coal above sea level, but both the horizontal contour of the troughs and arches and the depth of the beds. Note that the depth of the Pittsburg coal or reference stratum at any point is obtained by subtracting its elevation from the elevation of the surface at the same point as shown by the topographic map. For illustration, supposing the position of the Pittsburgh coal at Hizer, Putnam county, is desired; it would be seen by a glance at the map that the elevation of the surface is 664 feet A. T. at this point and that the 550 foot structural contour line passes through the same place; therefore, the coal here is then 664 feet minus 550 feet, or about 114 feet below the surface.

"As a rule, these structure contours are only approximately correct from the very nature of the data from which they are made, being estimated on the assumptiion that over small areas the rocks maintain a uniform thickness, when it is a

well known fact that in some places the interval between two easily determined strata will vary many feet in a short distance. It follows that the position of the contour will be in error the amount the increase or decrease in thickness varies from the calculated thickness.

"Another cause of error is in the method of determining the elevation of the outcrop of the key stratum,or of the tops of the many oil and gas wells drilled down through the same. In many cases these altitudes were determined by spirit level, but the great majority were determined with the aneroid barometer. The aneroid was checked as frequently as possible on the spirit levels of the U. S. Geological Survey left at conspicuous points along the public highways in the preparation of their accurate topographic map of the Jackson-Mason-Putnam area in co-operation with the State of West Virginia. In this way the instrumental error is kept down. The errors may accumulate, or may compensate one another, but in any case it is believed that their sum is less than one contour interval that is less than 25 feet, and over much of the area of Putnam and Mason the possible variation from actual altitude will not likely be more than 10 to 20 feet." (R. V. Hennen's Report of the Marshall-Wetzel-Tyler Area. Page 62).

Detailed Geologic Structure.

The Jackson-Mason-Putnam Area occupies the middle or deepest portion of the Appalachian basin or the geo-syncline which enters West Virginia from Greene County, Pennsylvania, passes through Wetzel, Tyler, Pleasants and Wood counties, and enters this area in the Western portion of Jackson county. Dr. I. C. White gives the following description of this geo-syncline. (See pages 84-85, West Virginia Geological Survey, Volume II.)

"The central or deepest portion of the Appalachian basin or geo-syncline enters West Virginia from Greene county, Pa., at the southwest corner of the latter State, and crossing western Monongalia and eastern Wetzel counties, continues on through the State in a general southwest course across

PLATE XI—Old River Deposit, C. & O. R. R., Putnam County.

eastern Tyler, western Doddridge, central Ritchie, Wirt and Jackson, cutting eastern Mason and western Putnam, and central Cabell, to enter Kentucky from northern Wayne, ten miles above the mouth of the Big Sandy river. Where the axis of this great basin enters the State, and on to the southwest as far as Doddridge county at least, the Pittsburg coal is buried to a depth of 1,300 to 1,500 feet under the highest summits, or say 150 to 200 feet above tide, but from Doddridge county on southwestward, the basin begins to rise, and at the Kentucky line the Pittsburg coal overlooks the Big Sandy waters from an elevation of 800 feet above tide in the deepest portion of the trough."

The axis of the geo-syncline enters Jackson county near its western boundary line about S 15° W, passing through Independence one-half mile west of Sandyville and from there takes a more westerly course or about S. 48° W until it reaches the waters of Thirteen Mile creek, at which point it turns more to the south as far as the Kanawha river near Buffalo, where it assumes a southwesterly course to the Putnam-Cabell county line.

The stata of this area have a general rise to the northwest and southwest from this geo-syncline. The structure is very simple, as the rise is gentle and no decisive folds are found in the extreme western portion of Jackson county and the southern portion of Putnam county.

Byrnside Anticline. This is an arch in the rocks of the southern part of Putnam county, and it enters this area from Lincoln county. It extends through a small portion of the southern end of Curry district, running almost parallel to the Putnam-Lincoln county line until it reaches the Putnam-Kanawha county line where the arch crosses into Kanawha county, passing through the Browns creek gas field and recrossing into Putnam county near the head of Scary creek, where it gradually dies out.

Flat Fork Anticline. In the southeastern part of Jackson county, east of Gay, Washington district, the Flat Fork Anticline just reaches the Jackson-Roane county line, and the gas wells in that portion of Jackson county are on the western edge of this anticline.

CHAPTER IV.

THE GEOLOGY OF THE JACKSON-MASON-PUTNAM AREA.

Introduction.

The different strata of the earth's surface are classified by geologists into divisions based principally on the life, vegetable and animal, of the past ages as revealed by the fossils preserved in these strata. The main divisions of the geological classification are the following:

Cenozoic—Recent life forms.

Mesozoic—Less recent forms.

Paleozoic—Oldest forms of life.

Archaean—Generally crystalline rocks with fossils and direct evidence of life, largely destroyed.

The rocks which crop to the surface in West Virginia are mostly included in the Paleozoic division and the greater portion of the area of the State consists of rocks belonging to one subdivision of this era, the Carboniferous.

The subdivisions or ages of the Paleozoic are:

Carboniferous	Upper	Permian, or Permo-Carboniferous.
		Coal Measures, or Pennsylvanian.
	Lower, Subcarboniferous, or Mississippian.	

Devonian.

Silurian.

Ordovician.

Cambrian.

The stratified rocks of the Jackson-Mason-Putnam area are included wholly in the Upper Carboniferous, and the exposed beds are all above the Allegheny Series. The following table illustrates the subdivisions of the Upper Carboniferous as found in northern West Virginia:

TABLE OF GEOLOGICAL FORMATIONS IN WEST VIRGINIA.

UPPER CARBONIFEROUS.

Dunkard, or Permo-Carboniferous series (1100 to 1200 feet).

Monongahela Series (260 to 400 feet).

Conemaugh Series (500 to 600 feet).

Allegheny Series (225-350 feet).

Upper Freeport Coal.
Upper Freeport Limestone.
Boliver Fire-clay.
Upper Freeport Sandstone.
Lower Freeport Coal.
Lower Freeport Limestone.
Lower Freeport Sandstone.
Upper Kittanning Coal.
Middle Kittanning Coal.
Lower Kittanning Coal.
Lower Kittanning Clay.
Lower Kittanning Sandstone.
Vanport (Ferriferous) Limestone.
Clarion Sandstone.
Clarion Coal.
Clarion Clay.

Pottsville Series (Northern Section, 250-300 feet).

Homewood Sandstone.
Mount Savage Fire-clay.
Mount Savage Coal.
Upper Mercer Coal.
Lower Mercer Coal.
Upper Connoquenessing Sandstone.
Quakertown Coal.
Lower Connoquenessing Sandstone.

Sharon Coal.
Sharon Conglomerate.

Lower Carboniferous (750 to 4,000 feet).

Mauch Chunk Shales (100 to 2,000 feet).
Greenbrier Limestone (150 to 800 feet).
Pocono Sandstone (500 to 1,200 feet).

DEVONIAN.

Catskill Sandstone, 2,000 feet.
Chemung Shales, 2,500 feet.
Hamilton Shales, 1,200 feet.
Oriskany Sandstone, 250 feet.

Detailed Sections and Oil Well Records.

The following sections and records of drill holes will exhibit the character of the stratified beds in the different portions of the Jackson-Mason-Putnam area:

LONE CEDAR SECTION.

Aneroid section taken one mile south of the mouth of Pond creek at Lone Cedar, Grant district, Jackson county, descending from top of hill along county road.

	Thickness Feet	Total Feet
Sandstone, friable	42	42
Red limy shale	28	70
Sandstone, massive	40	110
Sandy shale	10	120
Red, limy shale	20	140
Sandstone, friable (Hundred)	40	180
Red and sandy shales	25	205
Red shales, limestone nodules	5	210
Sandstone, massive, fine grained, (Upper Marietta)	39	249
Red shales and concealed	64	313
Fine grained (Lower Marietta)	20	333
Concealed	6	339
Black slate and fire clay (Washington coal horizon)	2	341
Green shales (Washington)	6	347
Red shales	10	357
Sandstone, flaggy (Mannington)	20	377
Sandy shale, mixed with red shale	28	405
Sandstone, massive, coarse grained, conglomerate to level of river (Waynesburg)	50	455

Ravenswood Section.

The following section was taken descending the Charleston and Ravenswood turnpike, south of Ravenswood in Ravenswood district, Jackson county, combined with a well drilled on the Gilbert Fox farm, about 1893-94. Authority for record of well, W. H. McConnell, Ravenswood; also see West Virginia Geological Survey Volume I., pages 283-84:

	Thickness Feet.	Total Feet.	
Sandy shale and concealed	23	23	
Red shale	2	25	
Sandstone	20	45	
Sandy shale	25	70	Dunkard
Sandestone	25	95	Series.
Sandy shale	28	123	2.45′
Red shale	3	126	
Dark shale (Washington coal horizon)	2	128	
Sandy shale and concealed to top of well	52	180	
Drive pipe	65	245	
Gritty lime	80	325	
Red shale	10	335	
Blue shale	8	343	
Gritty lime	15	358	
Blue shale	5	363	
Red shale	17	380	
Lime	10	390	Monongahela
Blue shale	20	410	280′
Lime	26	436	Series
Red shale	12	448	
Sand	4	452	
Blue shale	16	468	
Sand and oil (Pittsburgh) (10″ casing)	53	525	
Coal (Pittsburgh)	4	525	
Blue shale	13	538	
Red shale	10	548	
Blue shale	10	558	
Sand and water	20	578	
Black shale	3	581	
White shale	53	634	
Sand and water	24	658	
Red shale	43	701	
Blue shale	5	706	
Sand and water	15	721	Conemaugh
Blue shale	7	728	462′
Red shale	83	811	Series
Lime	25	836	
Blue shale	38	874	
Sand and water	10	884	
Blue shale	30	914	
Sand and water	10	924	
Blue shale	30	954	
Black shale	33	987	
(Showing of oil at 843′; 7⅝″ casing at 853′)			

	Thickness. Feet.	Total. Feet.	
Sand and oil	147	1134	
Blue shale	20	1154	Allegheny
Black shale	20	1174	268′
Sand and water	40	1214	Series
Black shale	41	1255	
Sand and water	60	1315	
Blue shale	20	1335	
Lime	15	1350	Pottsville
Sand	41	1391	Series
Lime	6	1397	260′
Black shale	33	1430	
Salt sand	85	1515	
Blue shale	60	1575	Mauch
Lime	30	1605	Chunk
Pencil slate	12	1617	102′
Lime, Greenbrier	50	1677	
Big Injun sand (?)	70	1747	
Blue shale	38	1785	
Lime	20	1805	
Blue shale	40	1845	
Lime	40	1885	
Black shale	10	1895	
Sand	12	1807	
Black shale	15	1822	
Sand, "Squaw"	65	1887	
Blue shale	20	2007	
Lime	5	2012	
Black shale	100	2112	
Blue shale	95	2207	
Black shale	10	2217	
Sand	18	2235	
Blue shale	40	2275	
Lime	25	2300	
Blue shale	45	2345	
Lime	20	2365	
Black shale	22	2387	
Sand and oil (Berea)	9	2396	
Blue shale	25	2421	
Lime	15	2436	
Blue shale	27	2463	
Black shale	20	2483	
Blue shale	20	2503	

This section starts 521 feet above the Pittsburgh Coal and extends 107 feet below the Berea Sand.

The interval between the top of the Pittsburgh Coal and Berea Sand is 1866 feet.

Utica Section.

An aneroid section was measured along the road descending from Browning towards Utica, Grant district, Jackson county, with the following results:

	Thickness. Feet.	Total. Feet.
Sandy shale	20	20
Limestone, grayish (Upper Rockport)	5	25
Sandy shale and sandstone	40	65
Limestone (Middle Rockport)	5	70
Sandy shale and sandstone	12	82
Limestone (Lower Rockport)	3	85
Sandy shale and sandstone	37	122
Limestone, Nineveh	2	124
Sandy shale	11	135
Red shale	20	155
Sandy shale and sandstone	15	170
Red and sandy shale	50	220
Sandstone, massive (Rush Run)	35	255
Sandy shale, concealed and sandstone	20	275
Sandstone, massive (Jollytown)	30	305
Red shale	5	310
Sandy shale	23	333
Red shale	2	335
Sandy shale and sandstone	23	358
Red shale	5	363
Sandstone, massive (Hundred)	45	408
Red shale to creek (690′ A. T.)	10	418

This section shows four distinct strata of limestone. The Upper Rockport, the Middle Rockport and the Lower Rockport Limestone are present and the Nineveh Limestone occurs with a thickness of 2 feet, 37 feet below the Lower Rockport Limestone.

The Rush Run Sandstone occurs in massive ledges and is separated from the Jollytown Sandstone by sandy shale and sandstone, with a thicknes of 20 feet. The Jollytown Sandstone also occurs in a massive cliff.

Chestnut Ridge Section.

The following is an aneroid section descending from Chestnut Ridge, taken in Cooper district, Mason county, and connected up with the Rambo well located in Union district, Jackson county, just across the line along waters of Little Mill creek on lands of W. H. Rambo; well drilled by the Cairo Oil Company, January—March, 1909; record furnished the Survey by W. H. Rambo, Letart, W. Va.

	Thickness. Feet.	Total. Feet.	
Concealed	25	25	Dunkard Series 570′
Sandstone, friable	35	60	
Concealed	35	95	
Red shale	8	103	
Sandy shale and sandstone	30	133	
Red shale	23	155	
Sandy shale	2	157	
Sandstone, massive (Hundred)	50	207	
Sandy shale	10	217	
Dark red shale	15	232	
Red shale, mixed with sandy shale	7	239	
Sandy shale and sandstone	8	247	
Red limy shale	14	261	
Sandy shale	11	272	
Sandstone, massive	45	317	
Top of Rambo Well (Elevation, 700′ A. T. aneroid.)			
Conductor	14	331	
Red rock	21	352	
Lime (Lower Marietta Sandstone)	32	384	
Slate (Washington coal horizon)	5	389	
Lime, little water	6	395	
Slate	10	405	
Sand (Mannington)	30	435	
Red rock	70	505	
Red rock	30	535	
Lime (Waynesburg sandstone horizon ?)	35	570	
White slate	5	575	Monongahela 229′ Series
Lime	14	589	
Red rock	15	604	
Slate	10	614	
Red rock	20	634	
Lime	20	654	
Sand	25	679	
White slate	63	742	
Hard lime .....32′ } Shells ....25′ } Pittsburg sandstone	57	799	

	Thickness. Feet.	Total. Feet.	
Red rock	66	865	Conemaugh 570′ Series
Shale	5	870	
Red Rock	44	914	
Lime	5	919	
Red rock	45	964	
Slate	55	1019	
Hard lime	15	1034	
Sand	25	1059	
Slate	20	1079	
Sand	25	1104	
Slate	25	1129	
Red rock	10	1139	
Red rock	10	1149	
Slate	15	1164	
White slate	10	1174	
Lime	5	1179	
Sand	70	1249	
Slate	5	1254	
Sand, salt water	115	1369	
Slate	30	1399	Allegheny 199′ Series
Sand, three bailers of water	35	1434	
Slate	84	1518	
Sand, five bailers of water	25	1543	
Slate	25	1568	
Sand	70	1638	Pottsville 260′ Series
Slate	26	1664	
Sand	55	1719	
Slate	50	1769	
Lime	8	1777	
Sand, more water	51	1828	
Big Lime (Hole full of water at 1832′)	53	1881	Big Lime 100′ Series
Sand Lime	12	1893	
Big Lime	35	1928	
Big Injun sand ?	21	1949	
Break	21	1970	
Big sand water	15	1985	
Black slate	19	2004	
Slate	20	2024	
Sand	30	2054	
Slate	10	2064	
Sand	10	2074	
Slate	15	2089	
Sand (Big Injun)	65	2154	
Unrecorded	200	2354	
Slate and shells	30	2384	
Black slate	20	2404	
Berea sand	21	2425	
Slate and shells	202	2627	
Slate and shells to bottom	190	2817	

No showing of oil or gas was found in any of the sands. This section begins in the Dunkard Series and extends 392 feet below the Berea Sand.

The Pittsburgh Coal is entirely absent, while the Pittsburgh Sandstone is represented by shells (conglomerate sandstone) 25 feet thick and hard limes (fine grained sandstone) 32 feet thick.

The Monongahela Series has a thickness of 229 feet, and the Conemaugh Series, 570 feet. The interval between the bottom of the Pittsburgh Sandstone and the Berea Sand is 1605 feet.

Laurel Creek Section.

The following is an aneroid section descending into Right fork of Laurel creek 2 miles north of Kentuck, Washington district, Jackson county, W. Va., combined with the record of John Riley Well No. 1 (37). Record furnished the Survey by John Riley, Marietta, Ohio.

	Thickness. Feet.	Total. Feet.	
Sandy shale	2	2	Dunkard Series 324′
Red shale	3	5	
Sandy shale and sandstone, **Hundred,**	20	25	
Dark red shale	15	40	
Sandy shale and sandstone	15	55	
Red shale	10	65	
Sandy shale	5	70	
Sandstone and sandy shale	30	100	
Red shale with limestone nodules	10	110	
Sandy shale and sandstone	10	120	
Dark red shale	10	130	
Sandy shale	6	136	
Red shale	1	137	
Sandy shale	6	143	
Red shale	1	144	
Sandy Shale	1	145	
Red shale	10	155	
Sandstone, top portion flaggy, **Lower Marietta**	10	165	
Red shale	5	170	
Dark red shale	5	175	
Sandy shale and sandstone	20	195	
Sandy shale, mixed with red shale	7	202	
Red shale	3	205	
Sandy shale and sandstone	16	221	
Red shale	8	229	
Sandy shale 1, Sandstone, fine grained 15 } **Mannington**	16	245	
Red shale	5	250	
Concealed to top of **Waynesburg sandstone**	7	257	
Sandstone, Waynesburg, to top of John Riley well; elevation 712′ A. T.	38	295	
Conductor	14	309	
White sand	5	314	
Blue slaty sand	10	324	

	Thickness. Feet.	Total. Feet.	
Blue shale, part coal (Waynesburg)	4	328	Monongahela Series 289′
Blue slate	12	340	
White sand (Gilboy)	35	375	
Red rock	10	385	
Slate and red rock	90	475	
Red rock	10	485	
White sand and shells	75	560	
Gray sand	5	565	
Red rock	5	570	
White slate	10	580	
White sand (Pittsburgh)	10	590	
White slate	8	598	
White lime	10	608	
Coal (Pittsburgh)	5	613	
Blue slate	5	618	Conemaugh Series 502′
White slate	25	643	
White sand	5	648	
Limestone	14	662	
White slate	33	695	
Sand and shells	14	709	
White sand	56	765	
Slate	6	771	
Gray lime	6	777	
Red rock	11	788	
Gray sand	14	802	
White slate	14	816	
Red rock	40	856	
Gray sand	14	870	
Red rock	40	910	
Slate	5	915	
Lime	10	925	
Red rock	20	945	
Sand	50	995	
Red rock	15	1010	
Red lime	30	1040	
Hard, blue sand	45	1085	
Hard white sand	30	1115	
White lime	40	1155	Allegheny Series 299′
White slate	60	1215	
White sand (show of oil)	100	1315	
Gray sand	30	1345	
sand very hard	29	1374	
Blue lime	20	1394	
Black shells	10	1404	
Lime and shales	10	1414	

	Thickness. Feet.	Total. Feet.	
White sand, trace of black oil	6	1420	Pottsville Series 293′
Gray sand	52	1472	
Black shale	10	1482	
White sand	41	1523	
Black slate	24	1547	
Shaly sand	10	1557	
Black lime shales	15	1572	
Sand and shells	23	1595	
Black slate	40	1635	
Coarse white sand	4	1639	
Blue slate	10	1649	
White sand at top of salt	20	1669	
White sand (Salt sand)	48	1717	
Show of oil at 1706′			

A large flow of salt water was encountered in the salt sand and there was a considerable showing of oil.

This section begins in the Dunkard Series and extends into the Pottsville. The top of the well starts in the Waynesburg Sandstone where it occurs in a massive cliff along Laurel Creek. The thickness of the Monongahela Series is 289 feet, and the Waynesburg Coal is represented by blue shale, part coal, a thickness of 4 feet. While the Pittsburgh Coal is represented to be 5 five thick, possibly the greater part of this coal is black slate.

Rockport Section.

The following section was measured with hand level jointly by Ray V. Hennen and the writer eastward down the hill road leading from McKinley Church to the village of Rockport, located in Steele district, Wood county, near the head of Tygart creek, one mile and a half west of the Wirt-Wood county line, and four miles northeast of the Jackson-Wood county line. This section is very important in that it shows the true relative position in the Dunkard Series of the rocks of the several thick limestone ledges capping the hills in southern Wood county, and northeastern Jackson county.

	Thickness. Feet.	Total. Feet.	
Sandstone, with shale layers	27	27	
Shale, dark and limy	3	30	
Sandstone	9	39	
Shale, red	2	41	
Sandstone, massive, Gilmore	25	66	67.5′
Shale, sandy	1.3	67.3	
Shale, bituminous (Gilmore coal horizon)	0.2	67.5	
Fire clay	1	68.5	
Limestone 3.5			
Shale, sandy........ 6			
Limestone, dark gray on fracture........ 1			
Gilmore Limestone	10.5	79	
Shale, red	2	81	39.5′
Fire clay	1	82	
Concealed	2	84	
Sandstone, coarse and brown	6	90	
Shale, buff and sandy	10	100	
Limestone, gray and hard, fossiliferous, Upper Rockport	7	107	
Concealed and sandstone	20	127	
Concealed	10	137	35′
Limestone, Middle Rockport and concealed	5	142	
Concealed	10	152	
Sandstone, dark gray, micaceous, nodular	5	157	
Shale, buff and sandy	6	163	
Sandstone, shaly	3	166	
Shale, reddish	5	171	
Limestone, weathering dark gray .... 5′			37′
Limestone, dark gray, weathering white .... 3′			
Lower Rockport.	8	179	
Shale, gray and limy	5	184	
Sandstone, coarse and brown	8	192	
Concealed	3	195	
Limestone, nodular and brecciated	1	196	
Sandstone, coarse, brown and friable, Nineveh	20	216	44′
Concealed	2	218	
Limestone, gray and hard, Nineveh	5	223	
Shale, red	4	227	
Concealed	3	230	
Sandstone, coarse, brown, and micaceous, friable	5	235	
Shale, bright red	5	240	
Sandstone	6	246	84′
Shale, red	15	261	
Concealed	10	271	
Shale, red	21	292	
Sandstone, Burton	10	302	
Shale, red	5	307	

	Thickness. Feet.	Total. Feet.	
Limestone, brecciated, sometimes massive and dark gray	2	309	
Shale, red and sandy	11	320	38′
Sandstone, green micaceous, broken, Fish Creek	25	345	
Concealed and red shale	16	361	
Sandstone	10	371	
Concealed (mostly red shale)	16	387	
Sandstone, shaly, green, micaceous, Rush Run	10	397	53′
Fire clay (Dunkard coal horizon)	1	398	
Concealed	10	408	
Sandstone, nodular	5	413	
Shale	5	418	
Fire clay	1	419	
Sandstone, massive, greenish, micaceous, fairly coarse, cliff maker, Jollytown	20	439	46′
Shale, dark with fire clay at top (Jollytown coal horizon)	5	444	
Limestone, silicious, brecciated, Upper Washington	5	449	
Shale, sandy	11	460	
Concealed	5	465	
Sandstone, massive, quarried at Rockport, base 695 A. T., Hundred	40	505	61′
Interval as shown by outcrop at mouth of Hughes river	175	680	
Coal, Washington			

The above section gives the Nineveh limestone—Washington coal interval, 447 feet, as opposed to 507 and 521 feet respectively at Burton and Littleton, Wetzel county. The three limestone ledges, the lower one of which comes 39 feet above Nineveh limestone, have been designated by the writer and Ray V. Hennen, the **Upper Rockport, Middle Rockport,** and **Lower Rockport.** This section also gives the true horizon of the Jollytown coal, coming as it does directly over 5 feet of **limestone (Upper Washington)** and 236 feet above the Washington coal bed. The latter interval at Burton, Wetzel county, W. Va., is 255 feet.

Robinson Run Section.

The following section was measured descending the hill on Robinson run one mile and a half south of Sassafras, Robinson district, Mason county, and joined on to the Ray-

burn well (M-29) drilled on the land of Mrs. Rayburn by the Wheeling Natural Gas Company; record of well furnished the Survey by Mr. J. M. Hensley, Hartford, W. Va.:

	Thickness. Feet.	Total. Feet.	
Red shale	40	40	Dunkard Series. 193′
Sandy shale and sandstone	25	65	
Sandstone, coarse grained	30	95	
Sandy shale and concealed	45	140	
Sandstone, friable (Waynesburg)	53	193	
Fire clay (Waynesburg coal)	2	195	Monongahela Series 265′
Red shale	21	216	
Concealed	60	276	
Top of Rayburn Well; elevation, 614′ A. T.			
Conductor	15	291	
Mud (soft shale)	30	321	
Gray sand	20	341	
Slate	11	352	
Coal (Pittsburgh)	6	358	
Brown slate	49	407	Conemaugh Series 498′
Red rock	14	421	
Blue rock	20	441	
Hard sand	10	451	
Red rock	12	463	
Gray sand	8	471	
Fire clay	10	481	
Red sand	20	501	
Black slate (showing of oil and gas)	3	504	
Showing of oil	7	511	
Black slate	10	521	
Red rock	6	527	
Red rock	74	601	
Sand	5	606	
Red rock	50	656	
Blue slate	100	756	
Black slate	60	816	
Sand	20	836	
Black slate	20	856	
Cow Run sand	25	881	Allegheny Series 228′
Brown slate	25	906	
Light sand	33	939	
Coal? (Lower Freeport)	8	947	
White sand	99	1046	
Coal? (Kittanning)	7	1053	
Black slate	23	1076	
Coal?	8	1084	
Gray sand	52	1136	Pottsville Series 292′
Black slate and sand	50	1186	
Black sand	100	1286	
Slate	30	1316	
White sand (salt water)	25	1341	
Black slate	35	1376	

	Thickness. Feet.	Total. Feet.
Limestone (Big Lime)	115	1491
Black slate	85	1576
Dark sand full of water (Big Injun)	40	1616
Black slate (cased to 1776′)	100	1716
Gray sand	80	1796
Black slate	220	2016
Berea sand	30	2046
Slate (showing of oil)	458	2504

It is needless to state that the thickness of the coal beds of the Allegheny series as shown by this record is not correct.

The interval between the top of the Pittsburg Coal and Berea Sand in this section is 1664 feet.

Point Pleasant Section.

The following aneroid section was taken at Point Pleasant, Lewis district, Mason county, and connected with the Wagner well (No. M3), of which the record was furnished the Survey by Mr. L. Shiflet of Point Pleasant:

			Thickness. Feet.	Total. Feet.	
Red limy shales			20	20	
Concealed			35	55	
Red shales			5	60	
Sandstone, coarse grained			45	105	
Concealed			10	115	
Red shales			10	125	
Sandstone			10	135	
Concealed			35	170	Monongahela Series 248′
Sandstone, flaggy	15′				
Sandstone, coarse grained	20				
Sandstone, coarse grained with pebbles	5				
Sandstone, soft, coarse grained	2	Pittsburgh Sandstone	75	245	
Sandstone, flaggy	3				
Sandstone, fine grained	10				
Sandstone, fine grained	20				
Coal (Pittsburgh)			3	248	

	Thickness. Feet.	Total. Feet.	
Sandy shale	4	252	Conemaugh Series 482′
Red shale	4	256	
Impure limestone	2	258	
Sandy shale and concealed	22	280	
Coal and slate (Little Pittsburgh)	3	283	
Concealed	7	290	
Top of Wagner Well.			
Sand and gravel	12	302	
Red rock	148	450	
Lime and fire clay	20	470	
Sand	20	490	
Red rock	80	570	
Fire clay and slate	40	610	
Sand	15	625	
Brown shale	105	730	
Black slate	40	770	Allegheny Series 254′
Sand	30	800	
Slate	30	830	
Coal, Middle Kittanning	6	836	
Slate	14	850	
Sand	40	890	
Slate	30	920	
Sand	60	980	
Coal	4	984	
Sandstone	26	1010	Pottsville Series 296′
Broken sandstone	140	1150	
Slate	20	1170	
Sand	30	1200	
Slate	65	1265	
Sand	15	1280	
Big Lime	110	1390	
Keener Sand	10	1400	
Impure sand	130	1530	
Slate	20	1550	
Sand and lime	15	1565	
Slate and limestone	385	1950	
Sand (Berea), broken	23	1973	
Slate	541	2514	

No showing of oil or gas was found in any of the sands. The coals in the Allegheny Series are evidently mixed with slate, or possibly nearly all slate.

The Big Injun Sand seems to be absent from the section. The Berea Sand occurs 1705 feet below the top of the Pittsburg Coal.

Statts Mill Section.

The following aneroid section was taken descending the road into Statts Mill. Washington district, Jackson county, and joined to the Statts well (No. J-10); record of well furnished the Survey by Mr. Enoch Statts of Ripley.

	Thickness. Feet.	Total. Feet.	
Concealed	30	30	
Sandstone	20	50	
Sandstone and sandy shale	29	79	
Red shale	1	80	
Sandstone and sandy shales (Hundred)	45	125	
Dark red shale	15	140	
Sandy shale and sandstone	18	158	
Red shale	4	162	
Sandy shales	10	172	
Red shale	3	175	
Sandy shale and sandstone	23	198	
Red shales	2	200	
Sandstone, massive	22	222	
Sandstone and sandy shale	12	234	
Red shale	4	238	
Sandy shale	4	242	
Dark red shales	3	245	
Sandstone, massive	20	265	Dunkard
Red shale	5	270	Series
Concealed	40	310	430′
Sandstone, top portion flaggy	10	320	
Very dark red shale	7	327	
Sandy shale	1	328	
Sandstone	2	330	
Sandy shale	4	334	
Red shale	3	337	
Sandy shale	2	339	
Red shale	1	340	
Sandstone, dark, fine grained	10	350	
Sandy shale and sandstone	10	360	
Sandstone, conglomerate, top portion of Waynesburg 10′ Top of Statts Well, elevation, 640′ A. T. Conductor 10′ Slate 10 Lime 40 Waynesburg Sandstone	70	430	
Unrecorded	150	580	
Shale and red rock	210	790	Monongahela
First Cow Run sand	70	860	and
Red rock	20	880	Conemaugh
Red rock	254	1134	Series
Yellow slate	11	1145	800′
Black slate	85	1230	

PLATE XII—Sliding Hill Cut (Pomeroy Sandstone) B. & O. R. R., Hartford, Mason County.

	Thickness. Feet.	Total. Feet.	
Second Cow Run sand	110	1340	Allegheny and Pottsville Series 605′
Coal (Salt water)	8	1348	
Slate and shales	217	1565	
Lime	15	1580	
Gray sand	12	1592	
Slate	39	1631	
Gray sand	14	1645	
Slate and lime shells	138	1783	
Salt sand, showing of oil	42	1825	
Slate	10	1835	
Lime	30	1865	
Big Injun sand	52	1917	
Unrecorded to bottom	62	1979	

Hartford Section.

The following section was taken descending the hill at Hartford, Graham district, Mason county, and connected with a core drill hole on the Sehon farm (See West Virginia Geological Survey, Volume IV., pages 338-39):

	Thickness. Feet.	Total. Feet.	
Waynesburg coal horizon	0	0	Monongahela Series 279′
Concealed, mostly sandstone	25	25	
Sandstone, massive, coarse grained (Gilboy)	35	60	
Sandy shale	12	72	
Red shale	4	76	
Sandstone	8	84	
Red shale	2	86	
Sandy shale and sandstone	17	93	
Sandstone, massive	25	118	
Sandy shale	15	133	
Red shale	5	138	
Sandstone	10	148	
Sandy shale	10	158	
Red shale	15	173	
Concealed	35	208	
Red shale	10	218	
Sandstone, massive, coarse grained (Pittsburgh sandstone)	54	272	
Slate	2	274	
Coal, Pittsburgh	5	279	

	Thickness. Feet.	Total. Feet.	
Red Rock and shale	272	551	Conemaugh Series. 542′
White sandstone	35	586	
White shale	42	628	
Black slate	12	640	
White sandstone	20	660	
Brown and white shale	50	710	
White sand (Buffalo)	51	761	
Slate	20	781	
White sand, Mahoning	40	821	
Brown and white slate	35	856	Allegheny Series. 197′
Slate	6	862	
Slate and coal (Lower Freeport)	5	867	
White shale	8	875	
White sandstone	128	1003	
Black slate	8	1011	
Coal, clean, (Middle Kittanning)	7	1018	

Here the Upper Freeport coal is evidently absent, and the two coals reported as present in the Allegheny series would be the Lower Freeport, and Middle Kittanning, or Hocking Valley seam. The statement of 7 feet of clean coal at the base of this section should be taken cum grano salis.

Gay, Jackson County, Section.

The following aneroid section descending along the county road was taken at Gay, Washington district, Jackson county, and combined with the Hintzman well, drilled by the Carter Oil Company, the record of the well being furnished the Survey by Mr. Lee Cady of Spencer:

	Thickness. Feet.	Total. Feet.	
Sandy shale and sandstone	20	20	Dunkard Series. 287′
Red shale	1	21	
Sandy shale	11	32	
Red shale	45	77	
Sandstone	33	110	
Red shale	2	112	
Sandy shale	15	127	
Red shale	15	142	
Sandstone, bottom portion massive, top portion flaggy	45	187	
Red and sandy shale	25	212	
Sandstone and concealed	75	287	

	Thickness. Feet.	Total. Feet.	
Coal and slate (Waynesburg)	2	289	
Top of Hintzman Well, elevation 716′ L.			
Sandy shale and concealed	14	303	
Sandy loam	5	308	
Red rock	5	313	
Gravel	4	317	
Sand	6	323	
Red rock	10	333	
Sand	2	335	
Unrecorded (hole full of water)	8	343	Monongahela
White slate	35	378	Series.
Lime	15	393	301′
White slate	15	408	
Sand	45	453	
Red rock	15	468	
Lime	10	478	
White slate	20	498	
Red rock	5	503	
White slate.... 35′ } Pittsburgh			
Red rock...... 15 } Sandstone			
White slate.... 35 } horizon	85	588	
Red rock	10	598	
Pittsburg sand ?	80	678	
White slate	80	758	
Sand	55	813	
Red rock	65	878	Conemaugh
White slate	50	928	Series.
Red rock	50	978	565′
White slate	65	1043	
Red rock	20	1063	
White slate	50	1113	
Sand	40	1153	
White slate	10	1163	
Sand	20	1183	
Slate	60	1243	
Sand	15	1258	
White slate	10	1268	Allegheny
Sand	5	1273	Series.
White slate	20	1293	265′
Sand	25	1318	
Black slate	70	1388	
Sand	10	1398	
Black slate	20	1418	
Sand	5	1423	
Sand (2 bailers of water)	5	1428	
Black slate	10	1438	
Sand	80	1518	
Black slate	35	1553	
Sand (1st Salt)	55	1608	Pottsville
Black slate	45	1653	Series.
Sand (2nd Salt)	25	1678	610′
Black slate	140	1818	
Sand (3rd Salt)	20	1838	
Sand 3rd Salt), show of oil	10	1848	
Hole full of water (Sand)	180	2028	

	Thickness. Feet.	Total. Feet.
Big Lime	58	2086
Unrecorded	87	2173
Big Injun sand	25	2198
Slate and shells	394	2592
Brown shale	12	2604
Berea grit	10	2614
Berea shells	9	2623
White slate	5	2628

This record reveals a great eastward thickening in the Pottsville series.

The Monongahela Series has reached a thickness of 301 feet. The interval between the bottom of the Pittsburgh Sand and the top of the Berea Grit is 2026 feet, a thickening of 421 feet as compared with the W. H. Rambo Well in the Chestnut Ridge Section.

Sandyville Section.

The following section was taken descending into Island Run on the Right Fork of Sandy creek, one mile east of Sandyville, Ravenswood district, Jackson county, and joined on to the Murray Well No. 1:

	Thickness. Feet.	Total. Feet.
Sand	10	10
Limestone (Nineveh)°	2	12
Sandy shale	40	52
Concealed (shale and sandstone)	160	212
Shale, red	10	222
Sandy shale	10	232
Sandstone, massive	45	277
Red shale	10	287
Sandstone	19	306
Red shale	1	307
Sandstone	25	332
Red shale and sandy shale, mixed	20	352
Sandstone (Hundred)	12	364
Red shale	3	367
Sandy shale	10	377
Sandstone, shaly	20	397
Sandstone, massive (Upper Marietta)	35	432
Top of Murray Well, elevation 600′ A.T.		
Conductor	20	452
Unrecorded	455	907
Coal (Pittsburgh)	1′8″	908′8″
Unrecorded	326′4″	1235
Cow Run Sand	27	1262
Oil at		1250
Bottom of Well		1262

This section shows the interval between the Nineveh Limestone and the Pittsburgh Coal to be 895 feet.

Pliny Section.

The following section was measured descending a hill at Pliny, Buffalo district, Putnam county, and joined onto a core drill hole at the mouth of Plantation creek on the land of Nelson Handley Heirs. Record of core drill furnished the Survey by Mr. R. Nash of Buffalo, W. Va.

	Thickness. Feet.	Total. Feet.	
Concealed	35	35	Dunkard Series. 125′
Shale and sandstone	20	55	
Red shale	5	60	
Sandstone, massive, coarse grained (Waynesburg)	65	125	
Fire clay with dark slate and coal blossom (Waynesburg)	1	126	Monongahela Series. 246.5′
Concealed, mostly shale	54	180	
Sandstone	30	210	
Red shale, mixed with sandy shale	15	225	
Concealed	83	308	
Top of Core Drill Hole.			
Earth	2	310	
Red soapstone	20	330	
Red shale	18	348	
Sandstone	18	366	
Gray slate	4	370	
Black slate	0′9″	370′9″	
Coal (Pittsburgh)	0′9″	371′6″	
Red soapstone	4′6″	376	Conemaugh Series. 234′9″
Sandy shale	30	406	
Red shale	44	450	
Sandstone (Connellsville)	51	501	
Sandy shale	69	570	
Sandstone (Morgantown)	19	589	
Gray slate	1′6″	590′6″	
Black slate (Elk Lick coal)	9″	591′3″	
Gray slate	4′3″	595′6″	
Sandstone	5	600′6″	
Red shale	6	606′3″	

Here we find only a few inches of Pittsburgh coal at 245 feet below what appears to represent the Waynesburg coal.

The Elk Lick Coal represented by a black slate, occurs 219 feet below the Pittsburgh Coal, as compared with the Bill creek Section taken opposite Raymond City where it occurs 192 feet below the Pittsburgh Coal.

Bear Branch Section.

The following section was taken descending into Bear branch along the county road in Buffalo district, Putnam county, and joined onto the Henson Core Drill Hole (P-25), the record of which was furnished the Survey by Col. C. H. Freeman of Huntington, W. Va.:

	Thickness. Feet.	Total. Feet.	
Red shale and concealed	100	100	
Concealed, possibly sandstone	15	115	
Dark red shales	15	130	
Sandstone	8	138	
Red shale and iron-ore nodules	2	140	Dunkard Series. 285′
Sandstone, flaggy, micaceous	30	170	
Red shale and concealed	20	190	
Sandstone, massive	20	210	
Concealed	25	235	
Sandstone, massive, forming cliffs	40	275	
Red and sandy shale	10	285	
Top of Core Drill Hole; elevation, 635′ A. T. Aneroid.			
Drift	15	300	
Red shale	25	325	
Blue shale	20	345	
Red shale	25	370	
Blue shale	15	385	
Fire clay, cored	3½	388½	
Coal seam (Uniontown), estimated	1½	390	
Black slate	3½	393½	
Draw slate, pebbles	5	398½	
Brown shale	5	403½	
Sand, light	2	405½	
Blue lime	6	411½	Monongahela Series 316.5
Blue lime shale	6	417½	
Brown shale	9	426½	
Red rock shale	16	442½	
Blue rock	24	466½	
Red shale	17	483½	
Blue shale	23	506½	
Gray sand	9	515½	
Draw slate	26	541½	
Sandstone	40	581½	
Blue slate	10	591½	
White fire clay	10	601½	
Coal (Pittsburgh), thickness not given	..	...	

	Thickness. Feet.	Total. Feet.	
Blue slate	20	621½	Conemaugh Series 168'
Coal (Little Pittsburgh)	..	...	
Conglomerate	1	622½	
Brown slate	7	629½	
White fire clay	5	634½	
Blue shale	10	644½	
Sand	10	654½	
Black slate	10	664½	
White fire clay	15	679½	
Gray sand	10	689½	
Brown slate	5	694½	
Unrecorded	5	699½	
White sand	10	709½	
Brown shale	10	719½	
Blue stone	10	729½	
Blue rock	10	739½	
Red rock	10	749½	
Blue rock	10	759½	
Red rock	5	764½	
Blue rock to bottom	5	769½	

The writer has not taken into consideration the thickness of the coals, as they were not given, but has carried the footings of the hole to the bottom, so the footings will have to be added to the thickness of the coal seams in order to get the correct depth of the hole; the probabilities, however, are that the Pittsburgh coal was thin.

Elmwood Section.

The following section was measured along the road descending into Elmwood, Union district, Mason county, and joined onto the William Thornton core drilling the record of which was furnished the Survey by Mr. C. H. Freeman, Huntington, W. Va.:

	Thickness. Feet.	Total. Feet.	
Red shale, limestone nodules	21	21	Dunkard Series 335′
Dark shale	1	22	
Sandstone, massive	40	62	
Sandy shale	15	77	
Red shale	5	82	
Sandstone	17	99	
Red shale	1	100	
Sandstone	20	120	
Red and sandy shale	20	140	
Red shale, with limestone nodules	10	150	
Sandy shale	10	160	
Red shale	10	170	
Sandstone	10	180	
Red sandy shale	5	185	
Sandstone and concealed	60	245	
Concealed	10	255	
Sandstone, flaggy	10	265	
Top of Thornton Drill Hole, elevation, 630′ A. T. Aneroid.			
Drift	25	290	
Blue shale	10	300	
Red rock	5	305	
Blue shale	10	315	
Red rock	10	325	
Blue shale	10	335	
Red rock	5	340	Monongahela Series 296′
Blue shale	15	355	
Red rock	10	365	
Blue shale	10	375	
Red rock	15	390	
Sand	17	407	
Red fire clay	8	415	
Sand, white	25	440	
Red rock	41	481	
Red rock	10	491	
Blue shale	10	501	
Limestone	10	511	
Red rock	20	531	
Draw slate	60	591	
White sand	25	616	
White fire clay	5	621	
Slate and coal (Pittsburgh)	10	631	

	Thickness. Feet.	Total. Feet.	
Black slate	8	639	Conemaugh Series 41′
Fire clay	4	643	
Blue slate	14	657	
Red slate	15	672	

The Pittsburgh Sandstone is here represented by "draw slate" 60 feet thick, and white sand 25 feet, making a total thickness of 85 feet. The Pittsburgh Coal is mixed with slate and the record does not show the thickness of clean coal.

Oldtown Creek Section.

The following section was taken descending into Oldtown creek measured along the road in Cooper district, Mason county, and joined onto the S. B. Cullins core drill hole (M-14), the record of which was furnished the Survey by Col. C. H. Freeman of Huntington, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandy shale	15	15	Dunkard Series 390′
Impure limestone	2	17	
Sandy shale	10	27	
Red limy shales	33	60	
Sandstone	29	89	
Red shale	16	105	
Sandstone, massive	35	140	
Red shale	15	155	
Sand shale	10	165	
Sandstone, flaggy	15	180	
Red and sandy shale	25	205	
Sandstone, massive, fine grained (Marietta)	50	255	
Sandy shale and concealed	20	275	
Sandstone, massive	30	305	
Red shale	15	320	
Sandstone, fine grained	20	340	
Red shale	12	352	
Sandstone (Waynesburg)	8	360	
Top of Core Drill Hole, 680′ A. T.			
Drift	15	375	
Sand, Waynesburg	15	390	

	Thickness. Feet.	Total. Feet.	
Shale, blue	20	410	Monongahela Series 265′
Lime	10	420	
Red rock	10	430	
Sand	15	445	
Red rock	10	455	
Blue shale	40	495	
Red rock	10	505	
Blue shale	10	515	
Red rock	15	530	
Blue shale	10	540	
Sand	10	550	
Fire clay	10	560	
Red rock	10	570	
Sand	5	575	
Fire clay	10	585	
Blue shale, sand parting	60	645	
Slate (Pittsburgh coal horizon)	10	655	
Red rock	10	665	Conemaugh Series 205′
Sand	15	680	
Fire clay (Little Pittsburgh)	15	695	
Blue shale	45	740	
Blue shale and sand	20	760	
Blue shale	30	790	
Shale, sandy	20	810	
Red shale	5	815	
Blue shale	5	820	
Blue sand shale	40	860	

The Pittsburgh Coal appears to be entirely absent in this section and the massive Pittsburgh Sandstone is here broken up into blue shale with sand parting.

Bar Run Section.

The following section was measured with an aneroid northeast down a hill road to the mouth of Bar run, 2 miles south of Ravenswood, Jackson county, connecting with the J. L. Poe core drill hole, the log of which was taken by R. F. Myers of Guysville, Ohio, from the test well drilled for coal, and its accuracy certified to by Mr. Myers, July 30, 1904. The record was furnished the Survey by Mr. J. L. Poe of Ravenswood.

	Thickness. Feet.	Total. Feet.	
Sandy shale	17	17	
Red shale	3	20	
Sandy shale	15	35	
Very red shale	25	60	
Sandy shale	5	65	
Sandstone, massive (Upper Marietta)	37	102	
Red shale	3	105	
Sandstone	15	120	
Sandy shale	25	145	
Red shale	5	150	Dunkard Series. 304′
Sandstone (Lower Marietta)	20	170	
Dark shale (Washington coal)	2	172	
Sandy shale	18	190	
Sandstone	10	200	
Top of Drill Hole, 600′ A. T. B.			
Surface	3	203	
Sandstone	14	217	
Red shale	29	246	
Soapstone	6	252	
Sandstone (Waynesburg)	52	304	
Slate (Waynesburg coal horizon)	2	306	
Sandstone	9	315	
Blue sandy shale	2	317	
Red shale	10	327	
Sandstone	2	329	
Gray shale	8	337	
Sandstone	4	341	
Blue shale	2	343	
Red shale	5	348	
Sandstone	3	351	
Blue shale	7	358	
Red shale	4	362	
Blue sandy shale	5	367	
Limestone	2	369	
Blue shale	10	379	
Sandstone	5	384	
Red shale	1	385	Monongahela Series. 267′9″
Blue shale	6	391	
Sandstone	1	392	
Red shale	20	412	
White shale	8	420	
Red shale	1	421	
Blue shale	10	431	
Sandstone	6	437	
Red shale	18	455	
Blue shale	3	458	
Red shale	16	474	
Blue shale	10	484	
White shale	10	494	
Sandstone, Pittsburgh	59	553	
Slate	1	554	
Sandstone	12	566	
Slate	2	568	
Coal (Pittsburgh)	3′9″	571′9″	
Flint	1′3″	573	

The Pittsburgh coal reported in this boring is probably slaty and not persistent, since a boring put down on the land of Samuel Webster, 10 miles farther down the Ohio river, found only 6 inches of bony coal and 2 feet of black slate at the horizon of the Pittsburgh coal, while near Letart another core drill boring on the land of Margaret Roush found no coal whatever at the Pittsburgh horizon.

Wilding Section.

The following section was taken descending from a hill, one mile south of Wilding, Ravenswood district, Jackson county, and combined with the J. M. White well (J-30), the record of which was furnished the Survey by J. M. White of Silverton, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandy shale	10	10	Dunkard Series. 586′
Limestone, grayish white (Nineveh)	2	12	
Sandstone and concealed	30	42	
Red and sandy shale	25	67	
Sandstone, massive	33	100	
Red shale	7	107	
Sandstone, dark	5	112	
Red shale	20	132	
Sandstone and sandy shale	30	162	
Red shale, limestone nodules	25	187	
Sandy shale and sandstone	30	217	
Red shale, limestone nodules	15	232	
Sandstone, fine grained	25	257	
Red and sandy shale	15	272	
Sandstone, massive	35	307	
Dark red shales with limestone nodules	40	347	
Light red shale, limestone nodules	3	350	
Sandy shale	15	365	
Red shale	25	390	
Sandstone, massive	25	415	
Sandy shale and concealed	5	420	
Red shale	14	434	
Sandy shale	6	440	
Sandstone, massive (Lower Marietta)	40	480	
Sandy shale and concealed	40	520	
Top of Boring, 575′ A. T. L.			
Conductor	14	534	
Sand (Waynesburg)	52	586	

	Thickness. Feet.	Total. Feet.	
Red rock	314	900	Monongahela Conemaugh and Allegheny Series 1076′
Water sand	60	960	
Slate	260	1220	
Cow Run sand	15	1237	
Slate	165	1402	
Big Dunkard Sand	88	1490	
Slate	10	1500	
Sand	25	1525	
Slate	137	1662	
Salt sand	75	1737	Pottsville Series 216′
Unrecorded	110	1847	
Second Salt sand	31	1878	
Slate	29	1907	Mauch Chunk 149′
Lime	55	1962	
Slate	12	1974	
Maxton sand	12	1986	
Black sand	11	1997	
Sand	15	2012	
Red rock and slate	15	2027	
Big Lime	105	2132	
Keener sand	54	2186	
Slate	56	2242	
Big Injun sand	50	2292	
Slate	3	2295	
Squaw sand	16	2311	
Lime and slate	331	2642	
Berea sand	5	2647	
Bottom of well	15	2662	

No oil or gas was found in this hole.

Poplar Grove Farm Section.

The following section was taken with a hand level descending the hill one-half mile south of Gallipolis Ferry, Clendennin district, Mason county, and joined onto the core drill hole sunk by the Uniontown Drilling Company, on the Poplar Grove Farm, and this joined to a corresponding stratum in the C. T. Beal well, located on Crab creek one mile southeast of core drill hole, in Clendennin district, the record of which was furnished the Survey by Mr. L. Shiflet of Point Pleasant, W. Va. (See West Va. Geol. Survey, Volume II., Page 402).

	Thickness. Feet.	Total. Feet.	
Sandstone	15	15	
Sandy shale	10	25	
Dark red shale, limestone nodules	10	35	
Sandstone	35	70	Monongahela Series 151′
Red shale, limestone nodules	10	80	
Sandstone, massive, coarse grained, conglomerate (Pittsburgh)	67	147	
Slate	1	148	
Coal (Pittsburgh)	3	151	
Sandstone and concealed	32	183	
Fire clay and coal mixed (Little Pittsburgh)	2	185	
Shale and sandstone	25	210	
Shale and concealed	25	235	
Top of Core Drill Hole, 615′ A. T.			
Surface	30	265	
Shale	80	345	
Sand and shale	27	372	
Soft shale	32	404	
Gray shale	10	414	
Red and white shale	43	457	
Shale	4	461	Conemaugh Series 524′
Limestone, Ames?	3	464	
Coal, Harlem?	0 4″	464 4″	
Sandy shale	15 8″	480	
Shale	5	485	
Lime	2	487	
Sandy shale	28	515	
Black shale	8	523	
Sandstone	2	525	
Slate	10	535	
Coal, Bakerstown	0′ 8″	535′ 8″	
Sandy shale	9′ 4″	545	
Sandstone, Buffalo	20	565	
Shale	15	580	
Sandstone, Mahoning	95	675	
Black shale, Upper Freeport	11	686	
Sandstone	27	713	
Slate and shale	12	725	
Coal ....1′ 11″ } Lower			
Slate, black ....7′ 0″ } Freeport	8′11″	733′11″	
Shale	3′ 1″	737	
Sandy shale	6	743	
Sandstone	14	757	Allegheny Series 190′4″
Shale	18	775	
Coal .... 3′ 0″ } Middle Kittan-			
Slate .... 7′ 0″ } ning Hocking			
Coal .... 2′ 0″ } Valley	12	787	
Slate	24	811	
Coal, Lower Kittanning	2	813	
Sandstone	52	865	
Coal, Clarion	0′ 4″	865′ 4″	

	Thickness. Feet.	Total. Feet.	
Sandstone, Roaring Creek, Homewood.	69	934′ 4″	Pottsville Series 279′
Black slate	25	959′ 4″	
Coal, Upper Mercer	0′ 3″	959′ 7″	
Slate	37′ 9″	997′ 4″	
Coal, Lower Mercer	1	998′ 4″	
Lime shale	12	1010′ 4″	
Shale to bottom	25	1305′ 4″	
Equals corresponding stratum in the C. T. Beal Well.			
Broken sandstone	59	1094′ 4″	
Slate	20	1114′ 4″	
Sand (hole full of water)	30	1144′ 4″	
Slate	65	1209′ 4″	Mauch Chunk 80′
Sand	15	1224′ 4″	
Big Lime	110	1334′ 4″	
Keener sand	10	1344′ 4″	
Impure sand (Big Injun), water	130	1474′ 4″	
Slate	20	1494′ 4″	
Sand and lime	15	1509′ 4″	
Sand and lime shells	385	1894′ 4″	
Sand, Berea, water	23	1917′ 4″	
Slate	541	2458′ 4″	

The core drill stopped in the Pottsville series, 170 feet below the top of the Homewood or Roaring creek sandstone, but the section is continued by the record of the Beal oil boring. The Allegheny beds in this record extend from 678 feet to 868 feet, thus having a thickness of 190 feet, in which only one coal bed, the Middle Kittanning, at 790 feet has a thickness sufficient to be commercially valuable at the present time

The Upper Freeport coal is absent, being represented only by black shale directly below a great sandstone mass which would correlate with the Mahoning at the base of the Conemaugh series.

What appears to be the Ames limestone with its underlying (Harlem) coal was found at 461 feet from the top of the section, while a thin representative of the Bakerstown coal was struck at 539 feet, 140 feet above the base of the Conemaugh series and 304 feet below the top of the core drill hole.

The above record is a good illustration of the paucity of coal in the Allegheny series, when its members lie below drainage level, although if the boring had been sunk a few miles farther to the southeast, it would doubtless have been much more barren of coal than the record shows (Vol. II. (A), page 621).

Waldo Section.

The following section was taken in descending the hill along the turnpike in Teays Valley district, Putnam county, one mile and a half southeast of Waldo:

	Thickness. Feet.	Total. Feet.	
Concealed	50	50	Dunkard Series 165′
Sandstone	10	60	
Red shale	3	63	
Sandstone	27	90	
Red shale, limestone nodules	15	105	
Sandy shale and sandstone	15	120	
Red shale	5	125	
Sandstone, coarse grained, conglomerate (Waynesburg)	40	165	
Red shale (Waynesburg coal horizon)	5	170	273′
Sandy shale	10	180	
Sandstone	25	205	
Red shale, limestone nodules	25	230	
Sandstone and sandy shale	5	235	
Red shale	5	240	
Sandstone, massive	25	265	
Red shale, limestone nodules	13	278	
Sandstone, flaggy	10	288	
Red and sandy shale	17	305	
Sandstone, massive, coarse grained, Rock Creek	75	380	
Fire clay and coal (Redstone)	5	385	
Sandy shale	11	396	
Sandstone	39	435	
Fire clay and coal (Pittsburgh)	3	438	
Concealed to Hurricane creek	18	456	

This section shows the thickness of the Monogahela series to be 273 feet and is interesting in that it shows both the Redstone and the Pittsburgh coal horizons.

Clover Section.

The following section was measured descending the hill along the county road in Union district, Cabell county, one mile west of the Mason-Cabell line:

	Thickness. Feet.	Total. Feet.	
Sandstone	10	10	Dunkard Series 89′
Red shale	15	25	
Sandy shale	10	35	
Sandstone, massive, coarse grained (Waynesburg)	54	89	
Black slate, mixed with coal (Waynesburg)	3	92	Monongahela Series. 253′
Red and sandy shale	30	122	
Sandstone, fine grained, buff	35	157	
Sandy shale	10	167	
Red shale	5	172	
Sandstone	28	200	
Black slate	5	205	
Sandstone, massive	22	227	
Red shale	8	235	
Sandstone, friable	24	259	
Concealed	8	267	
Red shale	15	282	
Sandy shale	18	300	
Fire clay and black slate (Redstone coal horizon)	2	302	
Sandy shale and sandstone	10	312	
Red shale with limestone nodules	25	337	
Fire clay (Pittsburgh coal horizon)	5	342	
Sandy shale and sandstone	15	357	
Sandstone and concealed to creek	7	364	

This section shows both the Redstone and the Pittsburgh coal horizons.

Sigman Section.

The following section was measured along the road descending into Sycamore branch, one mile and a half south of Sigman, Pocatalico district, Putnam county, and joined onto the O. P. Honaker Core drill hole, located on the Sycamore branch of the Left fork of Poca river, the record of the core drill hole being furnished the Survey by Plymouth Coal & Mining Company:

	Thickness. Feet.	Total. Feet.	
Red shale	20	20	
Sandstone	35	55	
Red shale	24	79	
Sandstone, flaggy	6	85	
Sandstone, limestone nodules	35	120	
Sandstone, flaggy, buff	25	145	Dunkard Series 295′
Red shale and concealed	35	180	
Sandstone, fine grained (Lower Marietta)	15	195	
Red shale and concealed	20	215	
Sandstone, coarse grained (Mannington)	40	255	
Red shale	15	270	
Sandstone, massive (Waynesburg)	25	295	
Red shale	10	305	
Sandstone, massive	8	313	
Top of Drill Hole P-43.			
Red clay and boulders	7	320	
Red shale	8	328	
Sandstone	4	332	
Gray shale	11	343	
Red shale	13	356	
Sandstone	8	364	
Blue shale	4	368	
Sandstone	9	377	
Red shale	29	406	
Sandstone	11	417	
Blue shale	4	421	
Red shale	3	424	
Sandstone	6	430	
Gray shale	4	434	
Red shale	7	441	
Gray shale	4	445	
Red shale	4	449	Monongahela Series 270′
Lime shale	10	459	
Red shale	5	464	
Gray shale	4	468	
Blue shale	8	476	
Red shale	2	478	
Blue shale	4	482	
Sandstone	9	491	
Red shale	5	496	
Blue shale	5	501	
Sandstone	4	505	
Sandstone	4	509	
Red shale	4	513	
Blue shale	11	524	
Sand shale	8	532	
Red and blue shale	9	541	
Red shale	5	546	
Blue shale	4	550	
Sandy shale	8	558	
Gray shale	4	562	
Sandstone	2	564	
Black slate	1	565	
Coal (Pittsburgh)	?		
Fire clay	2′9″		
Sandstone	4		

The thickness of the Pittsburgh coal is not given in the above section, but it is more than probable that it is still thick enough to be of commercial value.

The Pittsburgh sandstone is broken up into red shale, sandy shale and blue shale.

Bill Creek Section.

The following aneroid section was measured descending the hill one mile west of Raymond City, Scott district, Putnam county, and joined onto well No. 1 (13-P), drilled on lands of the Kanawha Fruit Farm by the Carter Oil Company, the record of which was furnished the Survey by Mr. Lee Cady of Spencer, W. Va.

	Thickness. Feet.	Total. Feet.	
Red shale	40	40	
Sandy shale and sandstone	55	95	Monongahela Series. 140′
Sandstone (Pittsburgh), coarse grained, glomerate	40	135	
Fire clay and slate (Pittsburgh coal horizon)	5	140	
Sandstone	30	170	
Concealed, mostly sandstone	130	300	
Sandstone	30	330	
Dark shale, slate and coal (Elk Lick)	2	332	
Slate	3	335	
Top of Boring, 587′ A.T.			
Dirt	5	340	
Sand	35	375	
Lime	5	380	
Sand	15	395	
Red rock	10	405	
White slate	55	460	
Sand	20	480	
White slate	10	490	Conemaugh Series. 600′
Red rock	20	510	
White slate	30	540	
Red rock	7	547	
White slate	28	575	
Red rock	5	580	
Sand	8	588	
White slate	17	605	
Coal, Brush Creek?	3	608	
Black slate	7	615	
Red rock	10	625	
White slate	32	657	
Sand	7	664	
White slate	46	710	
Sand	30	740	

	Thickness. Feet.	Total. Feet.	
Black slate (Upper Freeport coal)	4	744	Allegheny Series. 210′
Sand	24	768	
White slate	12	780	
Sand	5	785	
Coal (Lower Freeport)	2	787	
Black slate	8	795	
White slate	40	835	
Sand	45	880	
Black slate (Middle Kittanning)	7	887	
Sand	15	902	
White slate	3	905	
Lime	10	915	
Black slate	35	950	
Sand (Homewood (Roaring Creek)	55	1005	Pottsville Series. 737′
White slate	3	1008	
Sand (more water)	32	1040	
Black slate	95	1135	
Sand	35	1170	
Black slate	20	1190	
White slate	70	1260	
Sand	8	1268	
White slate	7	1275	
Sand	15	1290	
Black slate	22	1312	
Sand	8	1320	
Black slate	25	1345	
3rd Salt Sand, hole full salt water at 1413′	103	1448	
Black slate	2	1450	
Sand	24	1474	
Black slate	213	1687	
Little Lime	5	1692	Mauch Chunk and Mountain Limestone. 224′
Pencil cave	5	1697	
Big Lime	187	1884	
White slate	27	1911	
Big Injun sand, (25 bailers salt water at 1946′)	111	2022	
Black slate	11	2033	
Bastard lime	17	2050	
Slate	13	2063	
Limy sand	63	2126	
Lime	5	2131	
Slate	189	2320	
Sandy lime	18	2338	
Black slate	20	2358	
Brown shale	15	2373	
Berea grit	19	2392	
White slate	54	2446	

PLATE XIII—Hartford, Mason County.

The 3 feet of coal struck in the boring and given at 605 feet may possibly represent the Bakerstown coal instead of the Brush creek bed as doubtfully indicated. It is also possible that a portion of the 213 feet of black slates at the base of the Pottsville series may belong in the underlying Mauch Chunk beds of the Mississippian rocks. In any event, the record exhibits an immense southeastward expansion of Pottsville sediments in the 30 miles between Point Pleasant at the mouth of the Kanawha river where the Pottsville is less than 300 feet thick as shown on page ——, and Raymond City at the mouth of the Pocatalico where this series measures over 700 feet as given above.

The interval between the top of the Pittsburgh coal and the Berea Grit is 2238 feet as compared with 1664 feet, the interval in the Wagner Well at Point Pleasant.

Ripley Section.

The following is an aneroid section descending from Echo School House on the south of Ripley, Ripley district, Jackson county·

	Thickness. Feet.	Total. Feet.	
Sandstone and sandy shale (Nineveh)	30	30	
Red shale	5	35	
Sandy shale	20	55	
Green shale	1	56	
Red shale	5	61	
Sandstone and sandy shale (Burton)	30	91	
Red shale	5	96	
Sandy shale	5	101	
Red shale	5	106	
Sandy shale and sandstone (Fish Creek)	21	127	
Red shale	4	131	
Sandy shale and sandstone	18	149	
Red shale	2	151	
Sandstone (Rush Run)	20	171	
Red shale	20	191	
Dark red shale, mixed with sandy shale	20	211	
Sandstone	10	221	
Red shale	10	231	
Sandstone, massive (Jollytown)	40	271	
Red shale	13	284	Dunkard Series. 492′
Green shale	2	286	
Sandy shale and sandstone	20	306	
Red shale, limestone nodules	5	311	
Sandy shale (Hundred sandstone)	10	321	
Red shale " "	6	327	
Sandstone " "	6	333	
Red shale " "	1	334	
Sandy shale " "	2	336	
Red shale	10	346	
Red shale and sandy shale, mixed	37	383	
Red shale	4	387	
Sandstone (Upper Marietta Sandstone)	14	401	
Red shale (Upper Marietta Sandstone)	1	402	
Sandy shale (Upper Marietta Sandstone)	5	407	
Dark red shale (Upper Marietta Sandstone)	5	412	
Sandstone (Upper Marietta Sandstone)	10	422	
Red shale	15	437	
Concealed	50	487	
Sandstone (Lower Marietta) to creek at bridge at Ripley	5	492	

This section begins above the horizon of the Nineveh limestone and extends to the top of the Lower Marietta sandstone.

Tombleson Run Section.

The following section was measured descending a hill three miles south of Letart into Tombleson run and joined onto the John Swartz core drill hole (M-15), the record of which was furnished the Survey by Mr. C. H. Freeman, Huntington, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandy shale	35	35	Dunkard Series. 260′
Red shale	5	40	
Concealed	10	50	
Sandy shale	40	90	
Sandstone, friable, coarse grained	30	120	
Red shale	5	125	
Sandy shale	28	153	
Red shale	2	155	
Sandy shale	10	165	
Red shale	5	170	
Sandstone, massive, dark bluish grained (Mannington)	30	200	
Sandy shale	10	210	
Red shale	5	215	
Sandy shale (Waynesburg)	23	238	
Red shale "	2	240	
Sandstone "	20	260	
Top of Core Drill Hole, 640′ A.T.			
Drift	7	267	Monongahela Series. 258′10″
Shale, red and blue	80	347	
Sand, light shaly	23	370	
Shale, red	11	381	
Shale, brown	12	393	
Sand, white, micaceous	13	406	
Sand, bluish	6	412	
Coal, bony (Sewickley)	0′1″	412′1″	
Sand, brown	13	425′1″	
Shale, gray and blue	9	434′1″	
Shale, gray light	13	447′1″	
Shale, red	9	456′1″	
Lime, brickle	9	465′1″	
Lime, hard	10	475′1″	
Shale, red	10	485′1″	
Lime, gray	5	490′1″	
Sand, gray and light	28	518′1″	
Coal, bony (Pittsburgh)	0′9″	518′10″	

	Thickness. Feet.	Total. Feet.	
Lime	8'6"	527'4"	Conemaugh Series. 152'3"
Lime and sand	5'6"	532'10"	
Shale	5	537'10"	
Lime, light	10	547'10"	
Shale, red	5	552'10"	
Sand	0'6"	553'4"	
Lime, brown and light	38	591'4"	
Shale, red	10	601'4"	
Shale, dark	22	623'4"	
Shale, blood red and brown	6	629'4"	
Shale, bone .06, black pebbly	14'6"	643'10"	
Lime	8	651'10"	
Sand, very hard	3	654'10"	
Shale, slaty	3'3"	658'1"	
Shale, red	13	671'1"	

This section and record demonstrate the absence of the Pittsburg coal in workable condition from the Letart region.

Sissonsville Section.

The following section was taken descending a hill one mile north of Sissonsville, Kanawha county, one-half mile south of the Jackson-Kanawha line, and joined onto the Milan well No. 1, the record of which was furnished the Survey by Messrs. Humphrey and Cox:

	Thickness. Feet.	Total. Feet.	
Sandstone	20	20	Dunkard Series. 205'
Sandy shale and concealed	30	50	
Sandstone, massive, coarse grained and conglomeratic (Waynesburg)	85	135	
Fire clay (Waynesburg coal horizon)	1	136	Monongahela Series. 291'
Shale and concealed	30	166	
Sandstone and concealed (Gilboy)	25	191	
Red shale and concealed	25	216	
Sandstone, flaggy	35	251	
Red shale and concealed	55	306	
Sandstone and concealed (mostly sandstone), (Pittsburgh coal)	120	426	
Sandy shale and concealed	10	436	Conemaugh Series. 535'
Sandstone, flaggy	25	461	
Top of boring, 627' A.T.L.			
Surface	47	508	
Red rock	60	568	
Sand	25	593	
Red rock	70	663	
Lime	20	683	
Red rock	50	733	
Lime	25	758	
Red rock	40	798	
White slate	51	849	
Red rock	112	961	

Grit lime	275	1236	
Coal	2'6"	1238'6"	Allegheny
Lime	22	1260'6"	and
Lime	311	1571'6"	Pottsville
Sand	10	1581'6"	Series.
Limestone	25	1606'6"	1020'6"
Salt sand	375	1981'6"	
Lime (Greenbrier)	145	2126'6"	
Big Injun sand?	90	2216'6"	
Lime	108	2324'6"	
Slate	285	2609'6"	
Black slate	30	2639'6"	
Berea sand	14	2653'6"	

The above section shows the interval between the bottom of the Pittsburgh Sandstone and the Berea Sand to be 2213½ feet, a thickening of 186½ feet from the Hintzman Well in the Gay Section, a distance of S. 15° W. 16½ miles from the Hintzman Well.

The Monongahela Series has reached a thickness of 291 feet as compared with 301 feet in the Gay Section.

The Bill creek Section on page 83, located S 70° W. 12½ miles from the Sissonsville Section gives the interval between the top of the Pittsburgh Coal and the Berea Sand as 2238 feet or only 25½ feet thicker than the above section, showing that there is a gradual thickening of the Pottsville Series to the southeast.

Grimms Section.

The following section was taken with a hand level descending the hill at Grimms Landing, Union district, Mason county, and combined with the record of a core drill hole (M-4) on the George Grimms farm, the log of the latter being furnished the Survey by Mr. C. H. Freeman of Huntington, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandstone, buff, massive (Waynesburg)	53	53	Dunkard Series.
Coal and slate (Waynesburg)	2	55	Monongahela Series. 257′
Red shale	35	90	
Sandstone (Gilboy)	22	112	
Sandy and red shale	8	120	
Sandstone, massive (Uniontown)	40	160	
Red shale and concealed	60	220	
Concealed, mostly sandstone	20	240	
Surface drift	25	265	
Red rock	5	270	
Shale, with specks of coal	10	280	
Red rock	10	290	
Blue shale	10	300	
White fire clay, Pittsburgh coal horizon	10	310	
Red rock	35	345	Conemaugh Series. 462′
Light sandstone	20	365	
Blue slate	20	385	
Red rock, caving	15	400	
Red rock	30	430	
Blue shale	50	480	
Red rock	10	490	
Lime	10	500	
White shale and fire clay	60	560	
White shale	10	570	
Red fire clay	15	585	
Black shale, specks of coal	1	586	
Brown and blue rock	11	597	
Blood red rock	28	625	
Brown and blue shale	12	637	
Blue sand	13	650	
Light gray sand	20	670	
Red rock (3′ black lime)	30	700	
Blue shale, yellow mud	15	715	
Peacock color, shale	5	720	
Draw and black slate	20	740	
Black sand and slate	15	755	
Black shale, 4″ coal (Brush Creek),	2	757	
Dark slate	5	762	
Light slate	5	767	
White fire clay	5	772	

This section is important since it gives the distance between the Waynesburg coal and the Pittsburgh coal horizon in this portion of the Appalachian basin, and it also shows that the massive Upper Pittsburgh sandstone has locally been displaced with shale.

Kenna Section.

The following section was taken descending the hill one mile south of Kenna, Ripley district, Jackson county, and joined onto the McClain well (J-3), the record of which was published in West Virginia Geological Survey, Volume I (A), pages 477-78:

	Thickness. Feet.	Total. Feet.	
Concealed, mostly sandy shale and sandstone	80	80	
Red shale	10	90	
Sandy shale and sandstone	23	113	
Red shale	2	115	
Sandstone	15	130	
Concealed	20	150	
Sandstone and concealed	40	190	
Concealed	40	230	
Sandstone, flaggy	18	248	
Red shale, iron ore nodules	5	253	
Sandstone	10	263	
Top of Boring, 780′ A. T. B.			
Gravel	12	275	
Blue slate	28	303	
Sand, light, and water	10	313	
Blue slate (Waynesburg sandstone)	40	353	
Red shale	58	411	
Light shale	74	485	
Shale, red and shelly	92	577	
Light slate	18	595	
Lime, dark and hard......34			
Light slate 10			
Sand, hard 22			
Pittsburg Sandstone.	66	661	Dunkard, and Monongahela Conemaugh Series. 1213′
Black slate	24	685	
Light slate	10	695	
Shale, red	10	705	
Black slate	8	713	
Light lime, hard	18	731	
Slate, shelly	34	765	
Slate and shells	30	795	
Shale and red cave	40	835	
Lime and shells	6	841	
Shale and red cave	100	941	
Light lime	6	947	
Shale and red cave	20	967	
Blue sand	25	992	
Dark lime	5	997	
Slate	16	1013	
Light sand	25	1038	
Shale, light	55	1093	
Shale, red	20	1113	
Slate, white	10	1123	
Lime, dark	40	1163	
Sand, light (8¼″ casing)	50	1213	

	Thickness. Feet.	Total Feet.	
Slate, white	70	1283	Allegheny Series. 218′
Sand, white	45	1328	
Sand, light	35	1363	
Slate, light	12	1375	
Light lime, hard	33	1408	
Coal, Lower Kittanning,	5	1413	
Slate	18	1431	
Lime, very hard and white	64	1495	Pottsville Series. 657′
Black slate	22	1517	
Lime, dark	58	1575	
Black slate	77	1652	
Light lime	67	1719	
Salt sand (water, 1486′)	340	2059	
Black slate	4	2063	
Cased bottom salt sand	25	2088	
(Big) Lime, yellow and hard	75	2163	
Big Injun Sand: Light sand water 100′; Soft, white sand 40; Sand, hard and black 10	150	2313	
"Squaw" sand, shelly, some oil	35	2348	
Dark lime	30	2378	
Black slate	60	2438	
White slate to bottom (dry hole)	200	2638	

The above section is interesting in that it shows the absence of coal in the Monongahela and Conemaugh Series. The seam of coal noted at 1,408 feet is possibly a mixture of slate and coal.

Millwood Section.

The following aneroid section was taken descending a hill into Millwood, Union district, Jackson county:

		Thickness. Feet.	Total. Feet.	
Concealed, mostly, sandy shale		20	20	Dunkard Series.
Sandstone, fine grained, lower portion massive, top portion flaggy (Hundred sandstone)		30	50	
Concealed		40	90	
Red shale		10	100	
Sandy shale and sandstone		5	105	
Red shale, limestone nodules		5	110	
Sandy shale and sandstone		8	118	
Red shale		2	120	
Sandy shale and sandstone,. 5′ Red shale 2 Sandstone, flaggy, dark, hard, fine grained 8	Upper Marietta	15	135	
Red shales		15	150	
Sandstone		1	151	
Red shales		2	153	
Sandstone, flaggy		2	155	
Red shale		12	167	
Sandstone and shale		2	169	
Red shales		1	170	
Sandstone, flaggy 8′ Red shale 2 Sandstone, dark grained 8	Lower Marietta	18	188	
Sandy shale		3	191	
Red shale		2	193	
Sandstone, flaggy 8′ Sandstone, coarse grained, top portion full of pebbles 30	Mannington	38	231	
Concealed to river		38	269	

McClain Section.

The following section was taken descending a hill one mile southeast of McClain's P. O. into Lockhart fork of Sandy creek, Grant district, Jackson county:

	Thickness. Feet.	Total. Feet.	
Limestone (Lower Rockport)	1	1	Dunkard Series.
Concealed	5	6	
Sandy shale (Nineveh sandstone)	38	44	
Limestone (Nineveh)	2	46	
Sandy shale and sandstone	60	106	
Red shale	5	111	
Sandy shale and sandstone (Burton)	43	154	
Red shale	2	156	
Sandy shale and sandstone	19	175	
Red shale	1	176	
Sandy shale	7	183	
Red shale	2	185	
Sandy shale	3	188	
Sandstone (Fish Creek)	33	221	
Sandy shale	13	234	
Sandstone	12	246	
Sandy shale	15	261	
Sandstone, massive (Rush Run)	40	301	
Sandy shale and sandstone	60	361	
Sandstone (Jollytown) top limy	45	406	
Red shale	5	411	
Sandstone (Hundred) to creek level	39	450	

The above section shows in a general way the succession of the different strata in the northeastern portion of Jackson county.

The Burton Sandstone quite frequently caps the hills with massive cliffs, and the Rush Run Sandstone forms rugged cliffs, along the sides of the hills.

Goldtown Section.

The following section was taken descending a hill one mile east of Goldtown, Ripley district, Jackson county, and combined with the Boggess well, the record of which was furnished the Survey by Mr. Lee Cady of Spencer, W. Va.:

	Thickness. Feet.	Total Feet.	
Sandstone	25	25	Dunkard Series. 217′
Shale and concealed	20	45	
Coal and slate (Washington)	2	47	
Red and sandy shale	15	62	
Sandstone	40	102	
Red and sandy shale, mixed	35	137	
Sandstone, coarse, grained, conglomeratic (Waynesburg)	80	217	

	Thickness. Feet.	Total. Feet.	
Red and dark shale (Waynesburg coal horizon)	5	222	
Red shale	15	237	
Sandstone and shale	50	287	
Top of Boring, 660′ A. T. B.			
Gravel	18	305	
White slate	4	309	
Lime	3	312	
Red rock	10	322	
Sand	24	346	
Red rock	6	352	Monongahela Series. 309′
White slate	10	362	
Red rock	10	372	
White slate	11	383	
Red rock	8	391	
White slate	20	411	
Red rock	8	419	
Sand	22	441	
Slate	5	446	
Lime	19	465	
Red rock	5	470	
White slate	24	494	
Pittsburgh sandstone	32	526	
White slate	34	560	
Red rock	6	566	
White slate	45	611	
Red rock	25	636	
Lime and shells	58	694	
White slate	2	696	
Red rock	85	781	
White slate	20	801	
Sand	15	816	Conemaugh Series. 498′
White slate	10	826	
Lime	5	831	
Slate	10	841	
Sand	23	864	
White slate	15	879	
Sand	35	914	
White slate	35	949	
First Cow Run sand	30	979	
White slate	30	1009	
Black slate	15	1024	
Big Dunkard sand, water	85	1109	
Black slate	35	1144	
Sand	10	1154	
Slate	26	1180	
First Salt sand	34	1214	Allegheny Series. 295′
Black slate	60	1274	
Second Salt sand	5	1279	
Black slate	10	1289	
Lime	20	1309	
Black slate	10	1319	

	Thickness. Feet.	Total. Feet.	
Third Salt sand	115	1434	Pottsville Series. 465′
Water	90	1524	
Hole full of water	50	1574	
Pencil cave	210	1784	
Lime	15	1799	
Gray sand (Maxton)	10	1809	
"Big Lime," water	80	1889	
Big Injun sand, water	109	1998	
Black slate	76	2074	
Black sandy lime, very hard	10	2084	
Lime shells	115	2199	
Black slate	10	2209	
Lime shells	139	2348	
Brown shale	60	2408	
Berea grit, little gas	25	2433	

The above section shows a gradual thickening of the Pottsville Series to the southeast.

The section is important, in that it shows a total absence of any of the coals, below the Dunkard Series.

Big Creek Section.

The following section was taken descending a hill at the extreme southern end of Curry district, Putnam county, along the road leading into Big creek and thence connecting with the Isaac Bays well (P-37), the record of which was furnished the Survey by Holley and Stephenson of Charleston, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandstone, massive	28	28	Monongahela Series. 106′
Red shale	13	41	
Sandstone, massive (Pittsburgh)	63	104	
Coal and fire clay (Pittsburgh)	2	106	

	Thickness. Feet.	Total. Feet.	
Sandstone	15	121	Conemaugh Series. 518′
Red shale, limestone nodules	45	166	
Sandstone	28	194	
Red shale	4	198	
Limestone	2	200	
Sandy shale	12	212	
Limestone	1	213	
Sandy shale	8	221	
Sandstone, Connellsville	34	255	
Sandy shale	2	257	
Limy shale and limestone (Clarksburg)	3	260	
Red shale	10	270	
Sandy shale	5	275	
Red shale	4	279	
Sandy shale	10	289	
Sandstone	5	294	
Red shale	1	295	
Fire clay	2	297	
Red shale	9	306	
Limestone, yellowish, with yellow shale	3	309	
Sandstone	5	314	
(Top of Boring.)			
Soil and gravel	22	336	
Slate	138	474	
Sand	35	509	
Slate	40	549	
Sand	75	624	
Slate	85	709	Allegheny Series. 220′
Sand	15	724	
Slate	120	844	
Sand, salt water at 864′	40	884	
Slate	55	939	Pottsville Series. 955′
Sand	20	959	
Slate	71	1030	
Sand	30	1060	
Slate	85	1145	
Sand	55	1200	
Slate	35	1235	
Sand	70	1305	
Sand, salt water at 1485′	494	1799	
Big Lime	220	2019	
Slate	10	2029	
Big Injun sand	20	2049	
Slate and shells	180	2229	
Slate, black	277	2506	
Berea sand	16	2522	

The above shows a gradual thickening of the Pottsville Series to 955 feet.

The coals in the different series appear to be entirely absent.

The interval between the top of the Pittsburgh Coal and the Berea Sand is 2,400 feet, as compared with the interval in the Point Pleasant Section of 1,705 feet.

Lewis Section.

The following section was taken on the north bank of the Kanawha river at Lewis, Kanawha county, one mile and a half south of the Putnam-Kanawha county line, descending a hill and joined onto well No. 1 of the Coal River Oil and Gas Company (K-5), the record of which was furnished the Survey by Messrs. Crawford and Ashby of Charleston, W. Va.:

	Thickness. Feet.	Total. Feet.	
Sandstone, massive, coarse grained	50	50	Monongahela Series. 55′
Red shale and concealed (Pittsburgh coal horizon)	5	55	
Concealed	40	95	Conemaugh Series. 590′
Sandstone, flaggy, micaceous	55	150	
Red shale	50	200	
Sandstone and shale	86	286	
Red shale, limestone nodules	40	326	
Sandstone (Morgantown) (quarried for building purposes)	30	356	
Fire clay, mixed with iron nodules	4	360	
Dark sandy shale	40	400	
Concealed	35	435	
(Top of Well.)			
Quick sand and gravel	47	482	
Lime and pink rock	103	585	
Sand	60	645	
Slate, white (Upper Freeport coal horizon)	5	650	Allegheny Series. 185′
Sand	45	695	
Coal, very good (Lower Freeport)	5	700	
Sand	55	755	
Coal, very good (No. 5 Block)	5	760	
Sand	65	825	
Slate, black	5	830	

	Thickness. Feet.	Total. Feet.	
Sand	65	895	Kanawha Series. 550′
Coal, no good (Lewiston?)	4	899	
Sand	11	910	
Sandy lime	10	920	
Sand	10	930	
Pink rock	5	935	
Sand	10	945	
Slate (6″ casing)	40	985	
Lime	30	1015	
Sand	10	1025	
Slate and shells	10	1035	
Sandy lime	30	1065	
Slate	20	1085	
Broken lime	160	1245	
Top Salt sand	60	1305	
Little break sand	2	1307	
Sand	120	1427	
Slate	18	1445	
Sand, Nuttall	200	1645	New River. 200′
Slate	45	1690	Mauch Chunk. 90′
Red rock	10	1700	
Lime	15	1715	
Black lime	20	1735	
Big Lime (6¼″ casing)	205	1940	Mountain Limestone. 205′
Slate	15	1955	
Big Injun sand	50	2005	
Shells and slate	170	2175	
White slate	215	2390	
Black slate	37	2427	
Berea Grit sand	23	2450	
Black lime	15	2465	
Black slate	150	2615	
White slate	200	2815	
Black slate	195	3010	

The Salt sand formation has water all the way from 1245′ to 1645′. The Big Lime was very hard and white through the entire formation. The "Big Injun" sand was soft and made about 5 barrels of salt water per hour. The Berea sand was very hard with a little showing of dark oil. The drilling was continued 560 feet below the Berea sand, but no Gordon or other sands were found.

This section is very important as it shows the different formations from the Pittsburgh coal to the Berea sand, this

distance being 2,372 feet from the bottom of the Pittsburgh coal to the top of Berea sand.

The foregoing sections of the different series are so distributed as to give a fair idea of the thickness and proper horizon of the different formations in the Jackson-Mason area. The detailed description of the several formations of the series will now be given.

CHAPTER V.

THE DUNKARD SERIES.

The different beds of the Dunkard series in descending order have been given the following names in the study of the detailed geological formations:

Gilmore Sandstone.
Gilmore Coal.
Gilmore Limestone.
Upper Rockport Limestone.
Middle Rockport Limestone.
Lower Rockport Limestone.
Nineveh Sandstone.
Nineveh Coal.
Burton Sandstone.
Fish Creek Sandstone.
Rush Run Sandstone.
Dunkard Coal.
Jollytown Sandstone.
Jollytown Coal.
Upper Washington Limestone.
Hundred Sandstone.
Upper Marietta Sandstone.
Creston Reds.
Lower Marietta Sandstone.
Washington Coal.
Washington Shales.
Waynesburg Sandstone.

The Gilmore Sandstone.

The summit of the Dunkard series in the northeastern part of Jackson county appears to be capped by a massive sandstone known as the Gilmore sandstone. . This sandstone

was named by Professor J. J. Stevenson from its occurring in the township of that name in southwestern Greene County, Pennsylvania, where it is conspicuous in long lines of cliffs near the summits of the hills. "It is a massive bed* of coarse, yellowish, brown sandstone whose cliffs are always traversed by fissures that form a retreat for foxes when chased by hounds, and for that reason it is sometimes called the "Fox Rocks." It is an excellent stone for building purposes and has been quarried quite a good deal in the edge of Greene county, Pennsylvania, just across the line from Wetzel County, West Virginia."

This stratum just caps the highest knobs in a few places in the northeastern part of Jackson county and occurs 150 to 160 feet above the Nineveh limestone.

Gilmore Coal.

Often just beneath this sandstone there occurs a fire clay. In the northern part of the State there is often found some slaty coal at this horizon and it has been designated as the Gilmore coal by Ray V. Hennen.

Gilmore Limestone.

Just under this Fire Clay or Gilmore coal horizon, there occurs in the Rockport section, Wood county, a limestone 3½ feet in thickness and then a sandy shale of 6 feet with another foot of dark grayish limestone which has been termed the Gilmore limestone. This stratum does not seem to be persistent, since in some sections it is absent or the limestone has been replaced by sandstone.

Upper Rockport Limestone.

At a distance of 34 feet below the Gilmore sandstone there occurs a gray and hard fossiliferous limestone which has been named by the writer and Ray V. Hennen the Upper Rockport. The fossils are minute fresh water types that have not been identified.

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*Marshall-Wetzel-Tyler Report, page 171.

Middle Rockport Limestone.

At 30 feet below the Upper Rockport limestone there occurs another limestone ledge which has been termed the Middle Rockport. It is gray and hard and also contains minute fossils.

Lower Rockport Limestone.

At a distance of 29 feet below the Middle Rockport limestone there occurs another stratum of dark gray limestone. The blocks from this stratum weather white after they are broken from the bed and often these boulders in the fields give the tops of the hills the appearance of a flock of sheep lying on the bench where the stratum occurs.

These three limestone strata cap the tops of the high hills and ridges in the northeastern portion of Jackson county and add much fertility to the soil, since they are rich in carbonate of lime and also contain some gypsum as well as phosphoric acid. These limestones should be burned and distributed more widely over the soils of Jackson county. Smith Knob on the boundary line between Wirt and Jackson counties is capped with the Upper Rockport limestone which reaches a thickness there of about 7 feet. It is grayish and has a metallic ring.

The Nineveh Sandstone.

A sandstone ledge from 20 to 30 feet thick occurs above the Nineveh limestone and has been termed the Nineveh sandstone. The stone is coarse, brown, and friable at some points, while at other places it becomes a hard massive sandstone, making cliffs from 20 to 30 feet in thickenss. It has been frequently quarried for building purposes in the northern part of the State, but is not very satisfactory where it is exposed to the weather, since the grains of sand are so loosely cemented together that the blocks soon crumble. It ranges in thickness from 10 to 30 feet and its base comes from 2 to 10 feet above the Nineveh limestone. This sandstone occurs in the high points of the ridges in the northeastern portion of Jackson county. It often breaks in large boulders which roll down the hillsides and cover the flats below.

The Nineveh Coal.

A short distance below the base of the Nineveh sandstone a fire clay is often seen, which in the northern part of the State represents a coal, and was called by Dr. J. J. Stevenson, the **Nineveh coal** from the village of Nineveh, Greene county, Pennsylvania. In the northern part of the State it is seldom over 1 foot in thickness and has been frequently mined by the farmers for domestic use, as it furnishes a fair grade of fuel, although its ash is high.

"Accurate levels in the Burton section show this coal to be 990 feet above the top of the Pittsburgh coal." (Marshall-Wetzel-Tyler Report, page 175). In the Sandyville section it is probable that it is about 920 feet above the Pittsburg coal.

The Nineveh Coal.

One of the most important beds in the Dunkard series is the Nineveh limestone, and it was so named by Professor J. J. Stevenson from the village of Nineveh, Greene county, Pennsylvania. In the Jackson-Mason-Putnam area this limestone ranges from 1 to 5 feet in thickness and usually occurs in several layers separated by marly and sometimes bituminous shales. Some of the layers of this limestone are quite pure and others are silicious. In the Sandyville section it shows a thickness of 2 feet, and the same in the Rush run section. In the section south of Sandy creek in Jackson county, this limestone appears to be replaced by a sandy shale. However, on one or two hills south of Angerona the writer found it in an impure state near the tops of the hills.

This stratum occurs in a great many of the high hills in northern Jackson county and gives fertility to the soil.

Burton Sandstone.

At from 20 to 30 feet below the Ninevah limestone there occurs a sandstone which has been termed by Ray V. Hennen, the Burton sandstone. It forms steep bluffs wherever it occurs and it sometimes becomes massive and at other points it

is friable and erodes away easily, yet leaving steep slopes. It has not been used for building purposes and its horizon is often represented by sandy beds only.

Hostetter Coal.

Immediately underlying the Burton sandstone at Burton, Wetzel county, is found the Hostetter coal seam, so named by Dr. I. C. White in Bulletin No. 65 of the U. S. Geological Survey, page 33, where he has the following to say concerning this coal:

"Occasionally a bed of coal occurs at from 75 to 100 feet below the Nineveh limestone. It has been stripped out of the run on the old Hostetter farm near Burton, Wetzel county, West Virginia, where it is 10 to 12 inches thick and a little impure."

This coal is often represented in the Jackson-Mason-Putnam area by a soft fire clay of 2 to 12 inches in thickness, but no coal has been seen at this horizon.

The Fish Creek Sandstone.

At from 15 to 20 feet below the Burton sandstone there occurs a green, micaceous, broken sandstone stratum which has been designated the Fish creek sandstone by Professor J. J. Stevenson, from its outcrop on the stream of that name in the great cliffs near Deep Valley, Spring Hill township, Greene county, Pennsylvania. At this point its base comes approximately 840 feet above the top of the Pittsburgh coal. Dr. White describes this sandstone in Volume II, page 110, as follows:

"At 135 to 150 feet below the Nineveh coal there occurs another sandstone horizon known as the Fish creek sandstone. It makes great cliffs along the stream of that name in Marshall county, and also along the Baltimore & Ohio Railway between Littleton and Burton, Wetzel county, where it has been extensively quarried for building stone of which it produces a fair quality. This stratum, like the Nineveh and Gilmore sandstones above, makes a distinct terrace in the topography

so that its presence can be easily detected even when it does not stand out as a bold cliff." This sandstone very seldom gets massive in the Jackson-Mason-Putnam area, but throughout the northern portion of Jackson county, its presence is noted by the bench it forms.

The Fish Creek Coal.

The Fish creek coal which occurs immediately under the great Fish creek sandstone in Wetzel county is only represented by a small seam of fire clay in the Jackson Mason-Putnam area and often even this fire clay appears to be absent.

The Rush Run Sandstone.

The Rush run sandstone occurs from 20 to 40 feet below the horizon of the Fish creek coal and immediately over the Dunkard coal in Jackson county, and is a massive sandstone, ranging from 10 to 35 feet thick. This sandstone forms cliffs throughout the northern and central part of Jackson county and is very massive with brownish buff color and medium coarse grained.

The Dunkard Coal.

Immediately below the Rush run sandstone occurs the double bedded seam of coal named the Dunkard by Professor J. J. Stevenson from its outcrop on Dunkard creek, Greene county, Pennsylvania, where it occurs 750 feet above the top of the Pittsburg coal and from 35 to 45 feet above the Jollytown coal. The only opening found in this seam was along Cabin run of Sandy creek, Ravenswood district, on the farm of C. H. Moorehead, where it was once mined for some time, but owing to the bed's being very thin and the coal rather impure, the mine has been abandoned.

The following section was taken at the Moorehead opening:

PLATE XIV—Jollytown Sandstone, One Mile South of Liberty, Putnam County.

		Feet.
Sandstone, massive (Rush Run)		45
Coal and slate (laminated)	6″	Dunkard 1 7″
Coal, splint	8	
Slate	1	
Coal	4	
Sandy shale		10
Sandstone, massive (Jollytown)		25
Sandy shale		16
Red and sandy shale, mixed		25
Sandstone, fine, [illegible]uish grained, Hundred		30

The Dunkard coal occurs about 650 feet above the top of the Pittsburg at this locality. This is the only region where the coal has been opened, but at other places its presence was noted by a seam of fire clay, 6 inches to 1 foot in thickness.

The Jollytown Sandstone.

From 10 to 20 feet below the Dunkard coal occurs the Jollytown sandstone which is generally massive, ranging from 10 to 60 feet in thickness. This sandstone is a great cliff-maker throughout the northern and eastern portion of Jackson county, forming large massive cliffs around the hills. These cliffs are well exposed on the Left fork of Little Sandy creek; also on the different branches of Sandy creek east of Sandyville. Especially is this true of Cabin creek, one mile north of Liverpool, where the sandstone reaches a thickness of from 50 to 60 feet. The same is true of Rush run where its thickness is 60 to 65 feet. On Coon creek, one mile east of Duncan, the sandstone shows a thickness of 55 feet and forms great massive cliffs.

Turkey Creek Section.

The following section was taken descending into Turkey creek along the road two miles north of Duncan:

	Thickness. Feet.	Total. Feet.
Sandy shale	22	22
Limestone, Nineveh	3	25
Sandy shale and sandstone	36	61
Red shale	2	63
Sandy shale	5	68
Red shale	4	72

	Thickness. Feet.	Total. Feet.
Sandy shale	6	78
Sandy shale and sandstone	36	113
Sandy shale	45	158
Sandstone, massive, Rush Run	42	200
Sandy shale	40	240
Red shale	3	243
Sandstone, massive, Jollytown	40	283
Red shale	20	303
Sandy shale	3	306
Sandstone, bluish, fine grained, Hundred	37	343
Red and sandy shales	45	388
Sandstone, fine grained, bluish, (Upper Marietta)	45	433

This section shows the succession of the Rush run and the Jollytown sandstones in relation to the Nineveh limestone; also the Hundred sandstone and the Upper Marietta.

Lockhart Section.

Another important section which shows the succession of the different sandstone formations was taken along the road descending into Lockhart on the Left fork of Sandy creek, as follows:

	Thickness. Feet.	Total. Feet.
Sandy shale	5	5
Limestone, grayish, breaking with flinty fractures, Lower Rockport	5	10
Sandy shale and concealed	40	50
Limestone, Nineveh	2	52
Red and sandy shale	42	94
Red shales	15	109
Sandstone	30	139
Sandy shale	15	155
Red shale	2	157
Sandy shale, mixed with sandstone	18	175
Red shale	2	177
Sandstone	18	195
Sandy shale	30	225
Sandstone, massive, Rush Run	25	250
Sandy shale	5	255
Sandstone, massive, forming cliffs, Jollytown	50	305
Sandy shale	20	325
Red shale	10	335
Sandy shale	30	365
Red shale	2	367
Sandy shale	2	369
Red shale	16	385
Sandstone, fine grained, bluish, Hundred	20	405
Sandy shale and concealed to Sandy creek	50	455

Jollytown Coal.

The Jollytown coal which occurs from 30 to 50 feet below the Dunkard coal in the northern part of the State is absent throughout the Jackson-Mason-Putnam area and is represented only by a small streak of fire clay.

The Hundred Sandstone.

Throughout the Jackson-Mason-Putnam area there occur three similar sandstones forming three distinct benches. These sandstones are alike in structure and each is fine grained, bluish in color, and is used for the manufacture of grindstones, as well as for building stone.

The upper of these sandstone ledges has been named the Hundred sandstone from its occurrence at Hundred in Wetzel county, and the lower two sandstones have long ago been named by Dr. I. C. White, State Geologist, the Marietta sandstones from their occurrence at Marietta, Ohio, where they have been quarried for building stone and grindstones.

In order to get a proper classification and true relation between these three sandstone ledges, the following section was measured with a hand level, jointly by Mr. Ray V. Hennen, Assistant Geologist, and the writer, eastward down the river hill from the grindstone quarry to the Washington coal bed at a point one mile south of Marietta and in the State of Ohio, nearly opposite Brisco Station on the West Virginia side. This is a very important section, in that the true relation of the Marietta sandstones group in their type locality is shown with reference to the Washington coal.

Marietta, Ohio, Section.

	Thickness. Feet.	Total. Feet.
Sandstone, Jollytown, and concealed	40	40
Reds, dark, with limestone nuggets	20	60
Sandstone, fine grained, brown and bluish, quarried for grindstones, Hundred	41	101
Reds, dark	5	106
Concealed and sandstone	16	122
Sandstone, dark red	15	137

	Thickness. Feet.	Total. Feet.
Sandstone, bluish, medium grained with limestone, conglomerate at base, quarried for grindstones, Upper Marietta	52	189
Reds and concealed......45′ / Sandstone .... 2 / Reds ....15 } Creston Reds.......	62	251
Sandstone, bluish, medium grained, not quarried here, Lower Marietta	20	271
Concealed	5	276
Coal, Washington, 9″ to	1	277
Fire clay, shale, Washington	10	287

The Hundred Coal.

The Hundred coal which occurs from 2 to 5 feet under the Hundred sandstone in Wetzel county, appears to be absent through the Jackson-Mason-Putnam area since it was not seen at any place.

The Washington Limestone.

The Washington limestones found in the northern part of the State are almost always absent in the Jackson-Mason-Putnam area and the only indication of their existence is a thick silicious, brecciated layer of limestone, very impure, and containing very little lime.

The Upper Marietta Sandstone.

The interval between the Hundred sandstone and the Upper Marietta sandstone is 80 to 90 feet. This sandstone occurs directly above the Washington "A" coal. It forms very steep bluffs and quite frequently cliffs wherever it crops above drainage. This stratum plays an important part in making the steep hillsides throughout the entire area of Jackson county and also through eastern Mason. It has been quarried in several places and makes a very good building stone. It is also quarried and used for grindstones, which are shipped to different portions of the United States. These Marietta sandstones are especially valuable for grindstones, and are the second in

importance as a grindstone horizon in this country, being only surpassed by the Berea sandstone of Ohio.

The following account of the grindstone industry at Lone Cedar, Jackson county, is quoted from Volume IV, pages 431-2, West Virginia Geological Survey:

Lone Cedar Grindstone Company.

Quarry at Lone Cedar, Jackson County.

"At Lone Cedar, 10 miles north of the Sherman quarry and 21 miles south of Parkersburg on the Ohio river bluff and near the Baltimore & Ohio Railroad, a grindstone quarry has been operated on a small scale since 1897 by the Lone Cedar Grindstone Company of Parkersburg. The floor of the quarry is 200 feet above the Baltimore & Ohio track.

"Nine men were formerly employed and as high as $800 worth of stone has been quarried in one month, but the industry has declined in the last two years and the quarry is now about closed. The stone is cut out square, then hand dressed into a round shape, and finally turned to proper size and shape. The common sizes of grindstones made at this quarry are 4 feet in diameter with 18-inch face, which sell at $11 each, and 7 feet in diameter with 18-inch face. The stone is claimed to have an excellent grit and to have proved very satisfactory on the market.

"**Quarry.** The face of the quarry runs north and south, following the direction of the river bluff, and it is worked to the east. The upper ledge used as building stone is finely foliated, the planes marked by an abundance of black and white mica flakes, and the stone is fine grained. The lower or grindstone ledge is made up of small rounded quartz grains, and the fresh stone pulverizes easily. It seems to be loosely cemented yet forms a fairly solid rock, and contains white and black mica flakes. It weathers to a light yellow brown color, especially near the joint planes.

"A section of the quarry shows:

	Ft.
Dirt or clay cover	6
Red shales	30
Blue hard sandstone	12
Grindstone ledge	14
Blue shales.	

"The working of the grindstone ledge thus requires 48 to 50 feet of stripping and has proved too expensive for profitable working. The 12-foot ledge would make a good building stone with a good blue color and the shales are adapted to brick manufacture. A combination of these different industries would make the stripping profitable.

"The joints in this quarry run N. 70° W. and N. 20° W."

At Ripley a quarry is opened on Mill creek about one mile southeast of the Court House where the Upper Marietta sandstone reaches a thickness of 25 feet and is of a bluish color, making an excellent building stone. The abutments for the highway bridge recently erected across Mill creek at Ripley were built of this stone.

The following section, measured one-half mile southeast of Ripley, gives the different formations of this sandstone:

	Feet.	Feet.
Sandstone, friable	5	5
Sandstone, flaggy, dark	5	10
Sandstone, massive, light, bluish	6	16
Sandstone, flaggy	2	18
Red shales	14	32

A quarry in this rock has also been opened on Sycamore fork of Mill creek, one mile northeast of Ripley, where the following section was measured, showing its structure at that point:

	Feet.	Feet.
Sandstone, friable	15	15
Sandstone, fine grained, bluish	15	30
Red and sandy shale.		

The Upper Marietta sandstone forms cliffs wherever it crops along Sandy creek in Jackson county, and also along the Left fork of Sandy creek, north of Sandyville. It is also a cliff making rock south of Ripley along Tug fork of Mill creek where it gets massive and rugged, measuring sometimes 50 feet in thickness. At Skidmore it occurs 130 feet above Mill creek and has a thickness of 35 feet, cropping out in a rugged cliff.

This sandstone also makes the table lands in the neighborhood of Fair Plains and crops out in precipitous cliffs on

Parchment near Givens, where it attains a thickness of 40 to 45 feet and is medium coarse with a bluish tint. The sandstone makes cliffs between Ripley and Millwood along the north side of Mill creek.

The Washington "A" Coal.

At from 60 to 80 feet above the Washington coal in Jackson county there occurs a small bed of coal in the neighborhood of Duncan, Ravenswood district, which has been identifield as the Washington "A" coal. Dr. I. C. White has the following to say concerning this bed: "At 70 to 80 feet above the Washington coal there occure a bed of impure coal and coaly shale which is often present in the section along Dunkard creek. Sometimes the entire bed is 4 to 5 feet thick, but little of it is ever merchantable coal, being seldom more than bituminous slate. It is well exposed in the hills above Blacksville and Brownsville and contains many bi-valve crustaceans." (Bulletin No. 65, page 35, U. S. Geological Survey).

This bed also occurs in Marshall and Wetzel counties and can be traced in Marshall, Wetzel and Tyler counties where it occurs from 560 to 580 feet above the Pittsburg coal, and it occurs from 480 to 500 feet above the Pittsburg bed in the Jackson-Mason-Putnam area.

At Leroy, Ravenswood district, Jackson county, this coal was once opened just above the road at an elevation of 695 feet above tide, Barometer, but the opening has collapsed and the writer was unable to measure the thickness of the coal. However, he was informed that there was possibly from 6 to 8 inches of laminated coal and slate. This is the only place in Jackson county where this coal has been opened.

The Creston Reds.

Underlying the Washington coal and overlying the Lower Marietta sandstone, there occurs a formation of red clay which has been named by Mr. Ray V. Hennen, Assistant Geologist, the Creston Reds, owing to the fact that this stratum develops its greatest thickness near the village of Creston in the

eastern part of Wirt county. These reds occur throughout the greater portion of Jackson county, where they are above water level, attaining sometimes a thickness of 30 to 40 feet and quite frequently containing limestone nodules as also iron ore. In some places the reds are displaced by alternate layers of sandstone and red shale. These reds develop their greatest thickness along the Malhoan Ridge in Jackson county, east of Murrayville, where they reach a thickness of more than 30 feet and contain many limestone nodules that form fertile land, making an excellent soil for blue grass.

Lower Marietta Sandstone.

The Lower Marietta sandstone is also quite massive in many places over the Jackson-Mason-Putnam area and it has a thickness of from 20 to 40 feet. This sandstone is also used for building purposes, being in quality and structure about the same as the Upper Marietta. It has also an excellent grit for grindstones, and at Sherman in Ravenswood district, Jackson county, three miles north of Ravenswood, it is being quarried by the Eureka Stone Company of Marietta, Ohio. The sandstone used for grindstones is of a bluish color and has a fine grain and of excellent grit. This stone is shipped to Patterson, New Jersey. The company employs twelve men and is shipping from one to two carloads of grindstones per week. The thickness of the seam that they are working is about 6 feet, as the top portion appears to be a little too coarse to make good grindstones.

The Lower Marietta sandstone, like the Upper Marietta sandstone, is a great cliff making ledge throughout Jackson and Mason counties and a portion of Putnam county, where it crops above water. Its cliffs are not as high as those of the Upper Marietta, but at some places this ledge attains a thickness of from 30 to 35 feet. However, it is more frequently 20 feet thick than 30 feet. This stratum goes under Sandy creek between two and three miles east of Ravenswood and does not rise above water level until we come to the eastern portion of the county, near Leroy, where it makes a cliff about 20 feet in thickness.

Near Marshall on Little Mill creek there is a line of cliffs made by this sandstone and after descending Little Mill creek to Hereford, the Lower Marietta begins to pass under the same. At Ripley the abutments of the bridge recently constructed across Mill creek rest on the top of this sandstone. At Skidmore, in Washington district, this sandstone occurs about 40 feet above the level of the creek and has a thickness of 30 feet. It is massive and form cliffs.

Washington Coal.

The Washington coal occurs sometimes just under the Lower Marietta sandstone and at other times at a distance of from 5 to 10 feet below it. Its horizon above the Pittsburgh coal, is from 390 to 410 feet throughout the Jackson-Mason-Putnam area. Dr. I. C. White* has the following to say concerning this coal: "This bed, which is the only one of the Dunkard series that is workable over a wide area, was first described by the writer, and named the Brownsville coal from its occurrence at the village of that name in Monongalia county, West Virginia. Subsequently, however, the same coal was found in greater development at Washington, Pennsylvania, and it was designated from that locality by Professor Stevenson.

"It is always a multiple bed, being separated into two or three layers by divisions of slate. Occasionally these divisions are numerous and the entire thickness of the bed is 8 to 10 feet, but in all cases the only pure or merchantable coal is the bottom portion, which seldom exceeds 2½ to 3 feet. The upper part of the bed is nearly always very impure, since it contains so much ash and slate as to constitute it a mere bed of richly bituminous shale."

The Washington coal is present throughout all of Jackson county, a portion of Mason and in the northeastern part of Putnam county, but it nearly always occurs as a dark shale mixed with black shale sometimes laminated with layers of slate and coal, making a thickness of from 6 to 18 inches.

On Gin run one mile and a half southeast of Kenna, Rip-

*Bulletin No. 65, page 37, U. S. Geological Survey.

ley district, Jackson county, this coal has been mined in a small way by Mr. R. J. Morrison. A section at his opening measured as follows:

	Ft.	In.	Ft.	In.
Slate	0	2		
Coal.	0	6	1	6
Slate	0	3		
Coal	0	7		
Fire clay.				

The coal being so much interlaminated with slate is impure and of little commercial value.

Another opening has been made on lands of D. S. Keenes, one-half mile west of Kentuck, where the coal measured about the same thickness as at the opening on the Morrison Farm.

An opening on the waters of Eighteen Mile creek, two miles east of Extra, Union district, Putnam county, on land of William Bowles, shows the following section:

	Ft.	In.	Ft.	In.
Sandstone (Lower Marietta)			20	0
Black slate			3	0
Slate and coal, interlaminated	0	10		
Slate	0	2		
Coal	1	0	3	0
Slate	0	2		
Coal	0	10		
Fire clay bottom.				

This coal has been mined for several years by the owner and a portion of the trade of the neighborhood supplied therewith, but owing to the impurities in the bed, it is not very good for fuel use.

Another opening in the Washington seam has been made on the farm of J. L. Steele one mile west of Hugo, Union district, Putnam county, where the following section was taken:

	Ft.	In.	Ft.	In.
Sandstone (Lower Marietta)			20	0
Fire clay			1	0
Coal, laminated with slate	0	11		
Fire clay	0	11	2	0
Coal	0	2		
Fire clay bottom.				

The Washington coal was also worked on Sap Sucker run two miles northeast of Elmwood, Union district, Mason county, on the farm of Ivan Pickens. A section of the coal there shows as follows:

	Ft.	In.	Ft.	In.
Sandstone (Lower Marietta)			18	0
Slate			2	0
Coal and slate, interlaminated	0	10		
Coal	0	10	3	0
Slate	0	4		
Coal and slate, interlaminated	1	0		

The interlaminated slate mixed in with the coal makes this opening of very little commercial value.

The Washington Fireclay Shale.

Occurring just beneath the Washington coal is a dark greenish yellow shale. This shale is very persistent and can be easily identified by its peculiar appearance. It ranges from a thickness of 1 foot to 8 feet, and is a good marker for the Washington coal, as it appears to be always present even when the coal is absent and can be readily located.

Ray V. Hennen gives the following description of this stratum in the County Report for Wirt, Calhoun, and Roane, pages 163-164:

"Immediately under the Washington coal in the Wirt-Roane-Calhoun area there occurs a greenish yellow, impure fire clay, ranging in thickness from 5 to 10 feet. Wherever it outcrops along the public highways, its horizon is readily recognized owing to the peculiar type of slope and soil it produces on weathering. The writer has designated it the Washington Fire Clay Shale on account of its association with the coal of that name. In the area under discussion it is even more persistent than the coal itself, and was an invaluable guide in locating the horizon of this coal when the latter was absent from the measures. The writer collected a sample of this shale for analysis from its outcrop along the turnpike in the northwest edge of Spencer, Roane county, the composition of which, as reported by Prof. Hite, is as follows:

	Per cent.
Silica (Si_2O_3)	56.70
Ferric Iron (Fe_2O_3)	2.18
Alumina (Al_2O_3)	26.28
Lime (Ca O)	1.04
Magnesia (Mg O)	1.58
Potash (K_2O)	3.01
Soda (Na_2O)	0.40
Titanium (Ti O_3)	0.78
Loss on ignition	8.62
Total	100.59

"The analysis reveals a clay adapted to the manufacture of building brick, having the right percentage of silica and alumina. In a recent trip across Doddridge and Ritchie counties by the writer, it was found that this same characteristic shale accompanied the Washington coal wherever its outcrop was observed. Its color varies from a greenish yellow to a greenish gray, and often a brecciated limestone 8 to 10 inches thick, comes near the base of the shale."

In the Jackson-Mason-Putnam area it occurs sometimes just underneath the Washington coal and sometimes there is an interval of 5 to 10 feet between this shale and the coal.

The Washington Sandstone.

The Washington sandstone which often occurs in the northern part of the State seems to be absent in the Jackson-Mason-Putnam area.

The Little Washington Coal.

The Little Washington coal of Washington, Penna., does not appear to be present in the Jackson-Mason-Putnam area.

The Mannington Sandstone.

At from 15 to 20 feet below the Washington coal there occurs a sandstone that appears to be quite persistent in the Jackson-Mason-Putnam area and attains a thickness of from 10 to 20 feet. This stratum has been recently named by Prof. G. P. Grimsley (Volume IV., West Virginia Geological Sur-

vey, page 440) the Mannington sandstone, from its occurrence near the town of that name in Marion county, West Virginia, where it has been quarried, supplying stone for the city. He gives the following description of the same:

"At the west edge of the city of Mannington, J. D. Charlton has opened a small quarry which has supplied stone for the city for several years. The floor of this quarry is 50 feet above the creek level in the city. Oil wells at this lower level strike the Pittsburgh coal at a depth of 400 feet, which gives an interval of 450 feet between this coal and the sandstone at the quarry.

"The stone has a greenish gray color and is finely laminated along planes formed of black mica. The quartz grains are very small, giving the rock a close texture and white and black mica specks occur all through the stone, though especially abundant along the foliation planes."

This sandstone is very seldom massive in the Jackson-Mason-Putnam area, but seems to be flaggy and friable. It is not quarried as a building stone anywhere within the area.

Waynesburg "A" Coal.

The Waynesburg "A" coal which comes from 80 to 90 feet above the Waynesburg bed seems to be absent in the Jackson-Mason-Putnam area.

Waynesburg Sandstone.

At from 40 to 60 feet below the Washington coal a massive sandstone comes into the measures that was long ago designated the Waynesburg sandstone by the First Geological Survey of Pennsylvania, from its fine development near the town of Waynesburg in Greene county, Penna. Dr. I. C. White gives the following description of this formation in Bulletin No. 65 of the U. S. Geological Survey, page 245.

"It is one of the most persistent members of the Permo-Carboniferous series, since its eastern outcrop can be followed in an almost continuous line of cliffs from Greene county,

Penna., clear across West Virginia to the Big Kanawha river at Winfield.

"This stratum is the only one of the series that is generally conglomeratic or contains quartz pebbles larger than coarse sand grains. On account of this peculiarity the rock in question becomes a very important guide to the geologist in the interior of West Virginia, where so many of the Dunkard coals and limestones have disappeared, for it retains its pebbly character over a very wide area. When at its greatest development the thickness of this stratum approaches 75 to 100 feet. It is usually a grayish white rock with a yellowish cast on freshly broken surfaces, and its weathered boulders are usually covered with ridges and streaks of harder iron-bearing sand. The rock splits readily and frequently furnishes excellent building stone, the piers of the Baltimore and Ohio Railroad bridges across the Monongahela river near Fairmont having been constructed of it."

This sandstone outcrops along the western border of Jackson and Mason counties and it often attain a thickness of 50 and 70 feet. It is coarse grained and portions of it full of small pebbles.

At the northern boundary line between Wood and Jackson counties, this sandstone occurs from 40 to 60 feet above the level of the Ohio river, and Pond creek has cut out a channel in it at its mouth The south abutment of the highway bridge across Pond creek rests on the cliff made by this sandstone. It gradually rises in going down the river, since the general course of the river is to the southwest until at Murrayville the ledge is 50 to 60 feet above the railroad and a quarry has been opened there from which the rock is quarried and shipped. Prof. Grimsley gives the following account in connection with this quarry, in Volume IV., page 444:

Murray Brothers Quarry at Murrayville, Jackson County.

"Murray Brothers of Wheeling operate a quarry in the Waynesburg sandstone at the station of Murrayville on the Ohio river division of the Baltimore and Ohio Railroad. The

quarry was opened in 1899 and the Company has under lease about 80 acres of land. The stone has been used in the B. & O. pier work at Wheeling and in foundation work there. About one carload of stone is shipped daily and nine men employed at the quarry.

"**Quarry**. The quarry face runs east and west about 400 feet long, and is worked toward the south away from the railroad. The face is 38 feet high and the stone can be worked 6 feet lower, giving a total height of 44. The upper six feet of the rock has a lighter buff color, is softer and more or less shaly. The cover consists of three feet of soil.

"In the upper portion of the quarry occurs a number of hard nodules or niggerheads, one of which was measured 15 feet long and 12 feet thick. Around these nodules the rock is shaly and poorer in quality. White flint pebbles occur here and there through the sandstone.

"The joint planes run N. 80° W. and N. 60° E., also the main face joints nearly east and west. The joint planes are frequently curved and some come together forming triangular blocks. The joints are 16 to 25 feet apart so that large blocks can be quarried."

This sandstone is also quarried at Muses Bottom where it crops out along the railroad, but from Muses Bottom the ledge begins gradually to fall and at Sherman, three miles north of Ravenswood, the top of the ledge occurs at the water level in the Ohio river. Prof. Grimsley gives the following description of the quarry at Muses Bottom in Volume IV., page 442:

Hoover and Kinnear Quarry at Muses Bottom, Jackson County.

"Muses Bottom is a station on the Baltimore and Ohio Railroad, Ohio River division, one mile and three-fourths below Murrayville and about 26 miles below Parkerburg. At this place on the Noble farm a sandstone quarry was opened in 1903, and since 1905 has been operated by Hoover and Kinnear of Wheeling. In August, 1906, a second quarry

was opened a mile south of the Noble farm. The rock comes at the horizon of the Waynesburg sandstone.

"The stone varies from a light gray to a light buff in color, and is more or less banded by white mica flakes. The gray stone is close grained, but under a small lens is seen to be composed of well marked quartz grains. Some of the layers are conglomerates with the pebbles loosely held together and enclosing vitreous quartz fragments reaching a length of three-fourths of an inch. In the main quarry face, large boulders or niggerheads are seen with reddish brown color on the surface, but with very hard grained blue cores. Some of the stone layers are composed of a coarse sand which crumbles in the hand. Blocks are readily quarried 4x4x2½ feet in size, also 7x2x2 feet, and the output was shipped to Wheeling where it was used in the piers of the elevated track of the B. & O. and for building stone."

"**Quarry.** The quarry is located on the point of a hill with the face east and west and is worked to the north. The cover is 6 feet, but when the stone is followed back into the hill, this will increase to 20 and 40 feet.

A section of the quarry shows:

	Feet.	Feet.
Shaly sandstone and soil	6	
Sandstone, irregularly seamed	10	
Gray sandstone ledge	10	
Gray sandstone ledge	18	71
Gray sandstone ledge	17	
Gray pebbly sandstone	10	

"The new quarry, one mile below, shows a 35-foot face with the lower third yellow or buff in color, and the upper portion light gray in color similar to the upper quarry. The cover is 15 feet and the quarry is located in a ravine so that the stone is worked on both sides with a railroad switch at the center. This gives a double face of stone, increasing the capacity. Physical tests on this stone are given in another chapter .

"**Microscopical Structure.** Mr. S. L. Powell gives the following report of his microscopical study of a thin section of this sandstone: 'The rock as seen in the hand specimen

and the thin section, is a mixture of quartz, decomposed feldspar, kaolin, white and black mica, iron oxide, together with some argillaceous matter.

"The feldspar is almost entirely decomposed, only a few altered fragments remaining. The decomposition of the feldspar has resulted chiefly in the formation of kaolin, muscovite or sericite, which frequently form finely fibrous compact areas. The sericite together with the iron resulting largely from the decomposition of the biotite, frequently forms the matrix of the stone. Some secondary silica has developed, but not in sufficient quantity to firmly cement the quartz grains. The large quantity of yellow oxide of iron gives the color of the rock, and constitutes part of the cement. The abundance of decomposed feldspar, kaolin, and argillaceous material, renders the rock soft and friable. The quartz grains average about 0.4 millimeter in size."

The Waynesburg sandstone rises south out of the river bed at Letart and makes the Letart Falls. From there the course of the river being to the northwest, this sandstone soon rises in the hills until at Hartford, it occurs in their tops. The Waynesburg sandstone also crops out in massive ledges in the southeastern portion of Jackson county, and at Skidmore the Tug fork of Mill creek cuts a channel through it. At Statts Mills the abutments for the highway bridge rest on this sandstone, as also the milldam. The ledge rises more rapidly than the bed of the creek and on the Laurel fork of Tug, massive cliffs occur on each side. The sandstone in these cliffs is coarse grained and conglomeratic. Many pebbles occur along the creek channel at the horizon where the same cuts through this sandstone. The ledges are from 50 to 70 feet thick and ofter form shelving cliffs along the creek, as a stratum near the bottom of the sandstone being softer than the rest of the ledge is easly eroded.

The Waynesburg sandstone also crops out in massive cliffs along the waters of Middle fork of Poca river and its tributaries.

At Kentuck this rock forms cliffs 60 feet thick, very coarse grained and conglomeratic. At Fletcher the cliff is 70 feet high and begins 5 feet above the Waynesburg coal.

The Waynesburg sandstone also crops along the Kanawha river hill tops at Red House and forms rugged cliffs. The sandstone is coarse grained but is not so conglomeratic as in the southeastern portion of Jackson county. It also caps the hills south of the Kanawha river and in the vicinity of Upland bold cliffs occur near the summits where the sandstone is coarse grained but not conglomeratic.

The Cassville Plant Shale.

This, the basal member of the Dunkard series, was not studied for fossil plants in the Jackson-Mason-Putnam area, since these fossils appear to be quite rare. See Volume II. and II.(A), West Virginia Geological Survey for a general discussion of the Dunkard series, its age, and fossils.

CHAPTER VI.

THE MONONGAHELA SERIES.

The series of rocks embraced from the bottom of the Pittsburgh coal and extending up to the Cassville Plant Shale or to the top of the Waynesburg coal, an interval varying in thickness from 240 to 430 feet, has been named the Monongahela series by Prof. H. D. Rogers on account of the great development of its coal seams along the Monongahela river in Pennsylvania where these beds were first studied. Dr. I. C. White gives the following interesting description of this series in Volume II. West Virginia Geological Survey, pages 124-125:

"In the northern part of the State, nearly one-half of the rock material composing the Monongahela series is limestone, red shales are unknown, while massive sandstones are seldom found except along the eastern side of the Monongahela outcrop. The disintegration of these limestones, limy shales and other soft rocks at the north, gives origin to a gentle topography, and an extremely fertile soil, thus forming in Monongalia, Marion, Harrison, Lewis, Marshall, Ohio and Brooke counties, as well as in portions of Upshur, Barbour and Taylor, the finest agricultural and grazing regions in the State.

"In passing southwest from Harrison, Taylor and Lewis counties, however, the limestones practically disappear, along with most all the coal beds, while red shales come in as the limestones go out, apparently replacing the latter, and the sandstones grow more massive than in the northern area, thus giving origin to a rugged topography, and less fertile soils.

"These rocks extend over a wide area along the Ohio river and for many miles south of it, as far as the Great Kanawha, and in a narrow belt from that point to the Big Sandy

where in the center of the Appalachian trough the lowest of these beds passes into the air before reaching the Kentucky line.

"No marine fossils have ever been discovered in any of the limestones of the Monongahela series, and everything indicates that the deposits are of fresh water origin. The black slates always contain fish remains in the shape of scales and teeth, but nothing is known of their affinities, because they have never been studied. The water may have been estuarine, and slightly brackish, but the minute Cyprian, and Estherian-like forms whose skeletons—mostly broken and pulverized—make up the principal mass of the Monongahela limestones, testify clearly against their marine origin."

The following section of the Monogahela series near Hartford, Mason county, was measured descending the hill by Dr. I. C. White and published in Bulletin No. 65, U. S. Geological Survey, page 54:

Hartford Section, Mason County.

	Ft.	In.	Ft.	In.
Coal, Waynesburg, absent			0	0
Red shale	10	0		
Gray shale	5	0		
Sandstone	6	0		
Shales, brown and sandy	10	0		
Shales, red	2	0		
Concealed	14	0		
Red shale with limestone nodules	10	0		
Sandstone	20	0	250	0
Shales, variegated with limestone nodules near base	28	0		
Concealed	20	0		
Red shale	5	0		
Concealed	20	0		
Red shale	15	0		
Sandstone, massive, Pittsburgh	70	0		
Shales, gray, fossil plants	15	0		
Coal, Pittsburgh			5	6
Total			255	6

"Here the coal in the series is the Pittsburg, and all that is left of the great limestone of the northern portion of the State are a few limestone nodules near the center, while much red shale contrasts strangely with its complete absence at the north."

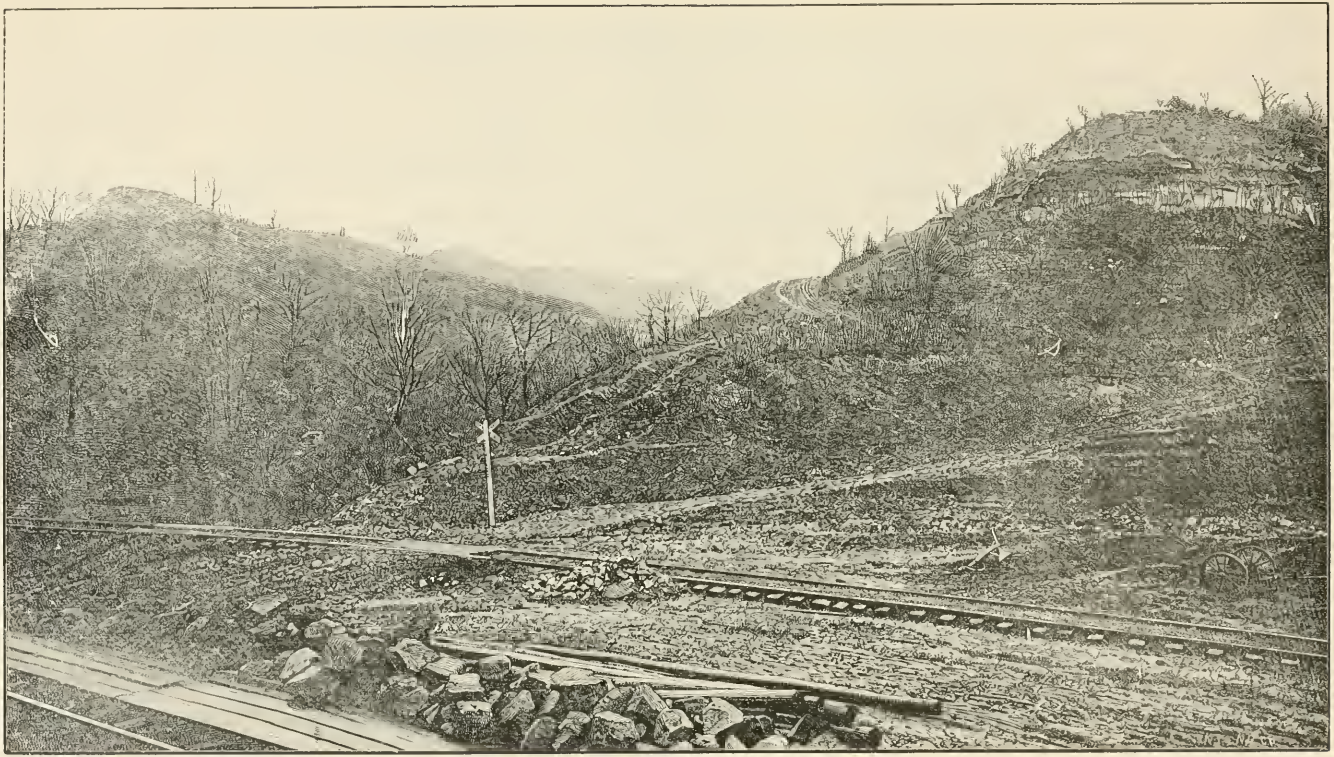


PLATE XV—Monongahela Series, Point Pleasant, Mason County (Bulletin 65 United States Geological Survey).

Another section taken by Dr. I. C. White near Arbuckle, Mason county, on the Great Kanawha river and published in Bulletin No. 65 U. S. Geological Survey, page 54, is as follows:

Arbuckle Section, Mason County.

		Ft.	In.	Ft.	In.
Coal, Waynesburg	Coal, slaty	0	10	3	0
	Coal, sulphurous	0	8		
	Shale, dark	0	5		
	Coal, good	0	8		
	Coal, slaty	0	5		
Shales, sandstone and concealed		150	0	178	0
Sandstone, blue		4	0		
Shales, red		2	0		
Sandstone, blue and hard		14	0		
Shales, variegated		8	0		
Coal, Sewickley		..	..	1	0
Sandstone, red		6	0	58	0
Shales, red		4	0		
Shales, variegated		48	0		
Coal, redstone horizon, impure fireclay				2	0
Sandstone, coarse, white, Pittsburgh				29	0
Coal, Pittsburgh horizon, fireclay and shale with a little slaty coal at bottom				10	0
Total				281	0

At Raymond City, near the mouth of Pocatalico river, Putnam county, Dr. I. C. White measured the following section and published same in Bulletin No. 65, page 56, U. S. Geological Survey:

Raymond City Section, Putnam County.

	Ft.	In.	Ft.	In.
Coal, Waynesburg, absent			0	0
Concealed, with shale	60	0		
Red shale	30	0		
Sandstone, gray, micaceous	4	0		
Limestone, in red shale	5	0		
Red shale	15	0		
Sandy shale, gray	30	0		
Red shales	40	0		
Sandy shales, yellowish gray	45	0		
Coal, redstone horizon, black shale			2	0
Sandstone, Pittsburgh	40	0	50	0
Shales	10	0		

		Ft.	In.	Ft. In.	Ft. In.
	Coal	0	4		
	Shale	0	4		
Coal, Pittsburgh "roof"	Coal	0	6		
	Shale	0	1	3′9″	
	Coal, slaty	1	0		
	Fire clay	1	6		
					10 7½
Coal, Pittsburgh main bench	Coal, good	6	0		
	Slate	0	0½	6′10½″	
	Coal, slaty	0	10		
Total					291 7½

This section gives the thickness of the Monongahela series as 291 feet 7½ inches in the southeastern part of Putnam county.

On page 74 of this volume, the writer gives a section combined with a record of core drill hole located at the mouth of Bar run, two miles south of Ravenswood, Jackson county, in which the thickness of the Monongahela series is 267 feet 9 inches.

On page 65 of this volume, the writer also gives a section taken at Hartford in the northern portion of Mason county which shows a thickness of 279 feet.

On page 60 of this volume, the writer also gives the Robinson run section combined with the Rayburn well, which shows the thickness of the Monongahela series there to be 265 feet.

On page 88 the writer gives a section at Sissonville, Kanawha county, at the southern edge of the Jackson county line, which shows the thickness of the Monongahela series to be 301 feet.

On pages 56-8 of this volume, a section combined with the John Riley well (J-7) gives the thickness of the Monongahela series as 289 feet, near the southeastern part of Jackson county.

The following section was taken descending a hill into Island creek, a branch of the Pocatalico river in Poca district, Kanawha county, one-half mile south of the Jackson county line and combined with the Jones well:

Island Branch Section.

	Thickness. Feet.	Total. Feet.	
Sandy shale and concealed	25	25	Dunkard Series. 85′
Sandstone, massive, coarse grained, conglomerate (Waynesburg)	60	85	
Red shale and fire clay (Waynesburg)	3	88	Monongahela Series. 263′
Concealed	12	100	
Sandstone (Gilboy)	25	125	
Red shale with limestone nodules	10	135	
Sandy shale and sandstone (Uniontown)	35	170	
Red shale	5	175	
Sandstone, coarse grained (Arnoldsburg)	25	200	
Sandy shale and sandstone	25	225	
Dark red shales	22	247	
Sandy shale and sandstone	20	267	
Red shale	10	277	
Sandstone (Sewickley)	23	300	
Red shale	10	310	
Sandstone	20	330	
(Top of Dr. Jones' Well (K-8) Pittsburgh sandstone)			
Slate	18	348	
Slate	152	500	Conemaugh Series. 582′
Coal (Elk Lick?)	2	502	
Slate	48	550	
Sand	30	580	
Red rock	80	660	
Pink rock and slate	140	800	
Sand	30	830	
Sandy lime	85	915	
Dark lime	15	930	
Black sand	70	1000	Allegheny Series. 260′
Coal (Lower Freeport?)	3	1003	
Black slate	12	1015	
Sand	10	1025	
Lime	10	1035	
Sand	45	1080	
Brown slate	25	1105	
Sand	10	1115	
Brown shale	60	1175	
Sandy lime	15	1190	
Sand	95	1285	Pottsville Series. 610′
Black slate	70	1355	
Sand	10	1365	
Black slate and lime shales	95	1460	
Sand	10	1470	
Black slate and shales	15	1485	
Salt sand (New River)	315	1800	
Red lime	45	1845	Maunch Chunk Series. 58′
Pencil cave	13	1858	
Big Lime	125	1983	
Big Injun sand	52	2035	

The following section was taken with a hand level descending the hill at Spilman, Waggener district, Mason county:

Spilman Section.

	Ft.	In.	Thickness. Feet.	Total. Feet.
Concealed			5	5
Sandstone (Gilboy)			20	25
Fire clay			5	30
Red shale, limestone nodules			20	50
Sandstone (Uniontown)			45	95
Sandy shale			10	105
Sandstone (Arnoldsburg)			20	125
Sandy shale			10	135
Sandstone			35	170
Sandy shale			5	175
Sandstone, massive, conglomeratic, (Pittsburgh)			56′6″	231′6″
Slate			20'	233 6″
Coal	0	4		
Slate	1	5		
Coal and slate, laminated	2	0		
Slate	0	8		
Coal and slate	0	6	(Pittsburgh coal) 9′6″	243
Slate	0	2		
Coal (bone)	0	6		
Slate	0	½		
Coal	3	10½		

This section begins below the horizon of the Waynesburg coal and hence does not give the full thickness of the Monongahela series. It will be noted from this section that the Pittsburgh sandstone attains a thickness of 56 feet 6 inches.

The following aneroid section was taken descending the hill one-half mile south of Mercers Bottom, Hannan district, Mason county, to show the character of the Monongahela series in the southwestern portion of the Jackson-Mason-Putnam area:

PLATE XVI—Coal Tipple, Linden Mine, Hartford, Mason County.

Mercers Bottom Section.

	Thickness. Feet.	Total. Feet.
Sandstone (Gilboy)	10	10
Red shales	30	40
Sandstone (Uniontown)	30	70
Red and sandy shale	20	90
Sandstone (Arnoldsburg)	30	120
Sandy shale	10	130
Sandstone, flaggy	15	145
Sandstone, hard and shelly and flaggy	10	155
Sandstone, coarse grained	63	218
Coal and slate (Pittsburgh)	3	221
Sandy shale and sandstone and concealed	40	261
Coal and slate (Little Pittsburgh)	10	271

If the coal at 218 feet be the Redstone, then the one at the bottom would be the Pittsburgh instead of the Little Pittsburgh.

Another aneroid section was taken descending the hill one mile and a half northwest of Vernon Church, Graham district Mason county, and combined with the record of core drill (M-22) on the Allen Hart farm, drilled by Olof Hanson and William Christofferson for J. M. Hensley of Hartford, the record of which was furnished the Survey by Mr. J. M. Hensley:

Vernon Church Section.

	Thickness. Feet.	Total. Feet.
Concealed	5	5
Sandstone, coarse grained, massive (Waynesburg)	55	60
Fire clay	1	61
Red and sandy shale	19	80
Sandstone (Gilboy)	35	115
Red shale	10	125
Sandy shale	8	133
Red shale	5	138
Limestone	2	140
(Top of Core Drill, 675′ A. T.)		
Surface	5	145
Sandstone	7	152
Fire clay	14	166
Sandstone	11	177
Red fire clay	30	207
Shale	13	220
Sandstone	4′7″	224′7″

	Thickness. Feet.	Total. Feet.
Shale and soapstone	12	236′7″
Red fire clay	19′5″	256
Sandstone (Pittsburgh)	33	289
Slate	5′5″	294′5″
Coal (Pittsburgh)	5′6″	299′11″
Fire clay	1′3″	301′2″

This section gives the thickness of the Monongahela series 239 feet 11 inches, if the "coarse grained" sandstone at the top of the section be the Waynesburg.

The following is the record of well No. 4 drilled by the United Fuel Gas Company on the land of the East End Land Company, Grant district, Cabell county, on top of Piney Mountain, just west of the Putnam-Cabell county line, and two miles north of Culloden; record of well furnished the Survey by the United Fuel Gas Company. The top of Piney Mountain is capped with the Waynesburg sandstone.

Piney Mountain Section.

	Thickness. Feet.	Total. Feet.	
Red shale	4	4	
Sandstone, coarse grained, Waynesburg	40	44	
Red shale and concealed	30	74	
Sandstone (Gilboy)	25	99	
Concealed	28	127	
(Top of Drill Hole, 978′ A. T.)			
Conductor	16	143	Monongahela
Red rock	39	182	Series.
Lime	15	197	291′
Sand	25	237	
Red rock	20	257	
White slate	15	272	
Red rock	8	280	
Sand (Pittsburgh)	55	335	

	Thickness. Feet.	Total. Feet.	
Slate	72	407	Conemaugh Series. 547′
Sand	45	452	
Red rock	30	482	
White slate	25	507	
Sand	45	552	
Red rock	25	577	
Black slate	15	592	
Red rock	20	612	
Sand	10	622	
Red rock	30	652	
Sand	45	697	
Red rock	20	717	
Slate and red cave	40	757	
Lime	10	767	
Sand	15	782	
White slate	10	792	
Red rock	15	807	
White slate	35	842	
Lime shells	40	882	
Sand and water	240	1122	Allegheny Series. 252′
Slate	12	1134	
Second Cow Run sand (Homewood)	90	1224	Pottsville Series. 681′
Slate	30	1254	
Lime	10	1264	
Second Cow Run sand	85	1349	
Slate	3	1352	
Sand and lime	109	1461	
Black slate	10	1471	
Sand	10	1481	
Salt sand	40	1521	
Salt sand	294	1815	
Little Lime	10	1825	
Big Lime	232	2057	
Big injun sand	100	2157	
Lime and sand	230	2387	
Squaw sand	110	2497	
Black slate and shells	84	2581	
Sand	4	2585	
White slate	6	2591	
Berea sand	17	2608	
Slate	3	2611	

This record shows the thickness of the Monongahela series to be 291 feet, and also that the intervals between the Pittsburgh coal horizon and the Big Injun and Berea sands are respectively 1722′ and 2246′.

DESCRIPTION OF THE MONONGAHELA FORMATIONS.

The following formations are included in the Monongahela series in Jackson-Mason-Putnam area:

Waynesburg Coal.
Waynesburg Limestone.
Gilboy Sandstone.
Uniontown Sandstone.
Uniontown Coal.
Uniontown Limestone.
Sewickley Sandstone.
Sewickley Coal.
Sewickley Limestone.
Redstone Coal.
Pittsburg Sandstone.
Pittsburg Coal.

The Waynesburg Coal.

The highest formation of the Monongahela series is the Waynesburg coal and was so named from Waynesburg, Greene county, Pennsylvania, where the coal has been mined for many years. This coal is the No. 11 seam of the early nomenclature in the coal seams of Ohio. Dr. I. C. White in Volume II., page 147, of the West Virginia Geological Survey, gives the following description of this bed:

"The seam is always multiple bedded, being generally separated into a 'roof,' 'upper and lower' divisions by shale and fire clay partings, the whole often nine to ten feet in thickness. This coal appears to attain its maximum thickness and importance in Marion and Monongalia counties, and the adjoining region of Greene county, Pennsylvania, since it thins down in every direction when traced away from these regions.

"The coal is always high in ash and moisture, and hence is a poor steam coal, and is used for that purpose only when nothing better is accessible. Of course, there is always some

good coal in the bed, but it is generally mixed up with the poorer quality in mining and the resultant fuel is never of first class grade."

In the Jackson-Mason-Putnam area, the crop of this bed is frequently exposed. In the southern portion of Jackson county it is mined in several places, but the seam is small, full of slate, and of very little commercial value.

The following measurement was taken at an opening on waters of White Oak creek of Poca river, Washington district, Jackson county, one mile and a half west of Advent, where this coal is mined by Alex. Jones:

Slate Roof.	Ft.	In.
Coal	1	2
Fire clay	0	6
Coal	0	10
Fire clay bottom.		
Total	2	6

Another opening of this seam is located on Mill fork of Middle fork of Poca river, one-half mile south of Kentuck, where the coal measures as follows:

Slate Roof.	Ft.	In.
Coal	0	8
Slate	0	6
Coal	0	6
Fire clay bottom.		
Total	1	8

The above sections show the character of the Waynesburg coal in this area, and it appears to thin out more to the southwest so that at Buffalo the writer found less than 6 inches of coal and slate exposed in one section. The outcrop of this seam has been placed on the Economic Geological Map accompanying this report.

Waynesburg Limestone.

The Waynesburg limestone that occurs from 25 to 40 feet below the Waynesburg coal is not present in the area described in this volume. Quite frequently some limestone nodules are mixed in the red shale occurring between the Waynes-

burg coal and the Gilboy sandstone, but no distinct ledges were found by the writer.

The Gilboy Sandstone.

From 5 to 10 feet below the Waynesburg coal there often occurs a massive rock that has been named the Gilboy sandstone by Dr. I. C. White in Volume II., page 150, West Virginia Geological Survey.

This stratum does not get very thick in the area described in this volume and is very seldom massive, ranging in thickness from 10 to 30 feet, coming from 20 to 30 feet below the bottom of the Waynesburg sandstone.

The Uniontown Sandstone.

A sandstone which is often massive comes into the measures a short distance below the Gilboy sandstone and immediately overlying the Uniontown coal. It has been named by Dr. I. C. White, the Uniontown sandstone. He gives the following description of this stratum in Bulletin No. 65, pages 58 and 59, U. S. Geological Survey:

"At 60 to 75 feet below the top of the series there frequently occurs a massive, gray sandstone whose horizon come immediately above the Uniontown coal; and hence, although the stratum in question is not prominent at Uniontown, it has been designated from its relations to the underlying coal.

"The rock has occasionally been mistaken for the Waynesburg sandstone, which belongs nearly 100 feet above. It is well exposed at Bobtown, Greene county, Pennsylvania, where it crowns the summit of the hill overlooking Dunkard creek as a bold cliff."

"It is probably the 'shallow oil sand' of Ritchie county operated on the Carroll farm by the Clark Oil Company, at Cairo, the highest known oil sand geologically in the State."

This sandstone makes massive cliffs 30 to 50 feet high along the Kanawha river in Putnam county. It makes bold cliffs throughout some portions of Mason county, especially

along the Kanawha river from Ambrosia to Grimm's Landing. There are also massive cliffs of this sandstone along the sloping hillsides of Kanawha-Eighteen Mile creek, and it forms prominent cliffs along the waters of Middle fork of Pocatalico river in Washington district, Jackson county, by this stratum.

The Uniontown Coal.

At a distance from 75 to 125 feet below the Waynesburg coal there often comes a bed of coal which has been named the Uniontown coal from its occurrence near the town of that name in Pennsylvania.

Throughout the Jackson-Mason-Putnam area this coal is nearly always absent, and often even the black slate which is often present when the coal is gone, appears to be wanting. It is exposed along the waters of Derricks creek in Poca district, Kanawha county, three miles southwest of the Jackson-Kanawha line, and a measurement taken there shows the following section:

	In.
Sandstone	
Coal and slate interlaminated	16
Fire clay bottom.	

Another opening on Trace fork of Pocatalico river in Poca district, Kanawha county, one-fourth mile west of the Jackson-Kanawha line, shows coal and slate mixed 16 inches in all.

From the sections of the core drill holes and the measurements of the openings exposed, it is evident that this coal is of no commercial value in the area described in this volume.

The Uniontown Limestone.

The limestone occurring between the Uniontown coal and the Sewickley coal in the northern part of the State appears to be almost entirely absent throughout the area described in this section. Often a limy sandstone appears to come at the same horizon.

The Fulton Green Shale.

Occurring immediately under the Uniontown limestone, there is often a bright green, finely laminated shale that has been named the Fulton Green Shale by Prof. G. P. Grimsley in the Ohio-Brooke-Hancock County Report, from its exposure at the town of Fulton, Ohio county, West Virginia, but this shale does not seem to be present in the Jackson-Mason-Putnam area.

Benwood Limestone.

The lower division of the great limestone of Rogers has been called the Benwood limestone from its outcrop along the Ohio river hills near the town of that name in Marshall county where it forms vertical cliffs consisting of alternate layers of hard limestone and limy shale. This limestone is not present in the area described in this volume, and neither is the Sewickley sandstone, or underlying Sewickley coal.

The Redstone Coal.

A seam of coal which has been designated by Prof H. D. Rogers the Redstone coal, occurs from 50 to 70 feet below the Sewickley coal and from 20 to 50 feet above the Pittsburg bed. It has attained sufficient thickness at several places in West Virginia to be mined on a commercial scale. Prof Bownocker, the State Geologist of Ohio, has identified the coal mined in Mason county as the Redstone coal, and a discussion of this coal will be taken up a little later.

The Upper Pittsburgh (Pomeroy) Sandstone.

In the northern and western portion of Mason county and portions of Jackson and Putnam counties, there outcrops a massive sandstone from 50 to 70 feet in thickness which has been generally designated as the Upper Pittsburg sandstone. Professor Bownocker of the Ohio State Geological Survey, calls this the Pomeroy sandstone from its occurrence at the city of Pomeroy, Ohio, where it has attained a thickness of 70 to 80 feet.

This sandstone does not crop out in western Jackson county, but is present as is shown from the record of the different oil well and core drill holes. In the core drill hole at Bar run, two miles south of Ravenswood, Jackson county, the sandstone shows a thickness of 59 feet.

Mr. F. W. Hammond, who has drilled several shallow oil wells in Jackson county, near Sandyville, is authority for the statement that this sandstone, in that neighborhood, attains a thickness of 60 feet and is hard and full of pebbles, making it difficult to drill.

The record of the gas well drilled near Gay, Washington district, Jackson county, shows this sandstone to be 80 feet in thickness.

This sandstone comes above the surface along the Ohio river at Hartford, Mason county, where it forms a massive cliff 60 feet high. It outcrops along the Ohio river to the southern portion of Mason county, forming great cliffs, especially near Gallipolis Ferry where the cliffs range in thickness from 70 to 75 feet.

The K. & M. R. R. has cut through this ledge at Point Pleasant in making the crossing over the Batlimore and Ohio Railroad.

Here this ledge is well exposed and the following measurements were taken:

	Thickness. Feet.	Total. Feet.
Sandstone, flaggy	15	15
Sandstone, coarse grained	20	35
Sandstone, coarse grained, with pebbles	5	40
Sandstone, soft, coarse grained	2	42
Sandstone, flaggy	3	45
Sandstone, fine grained	30	75

The Pittsburgh sandstone soon disappears in going up the Kanawha river as the measures dip into the Parkersburg syncline, and at Beech Hill, seven miles southwest of Point Pleasant, it has entirely disappeared.

When it comes above the surface again near Red House, it has lost its massiveness and is a flaggy sandstone, being often replaced by layers of red shale, as is shown in the dif-

ferent records of the several core drill holes sunk in Putnam and Mason county, north of the Kanawha river.

Along Hurricane creek in Putnam county, this sandstone again becomes massive and coarse grained and make rugged cliffs. These cliffs continue to the southeast and cap the top of the highest hills in the southern end of the county.

Along the waters of Pocatalico river, in eastern Jackson county, the sandstone ledge does not become massive, except occasionally. In most places it is soft, flaggy, and disintegrates readily, or often it is replaced with red shale.

The Upper Pittsburg sandstone has been quarried at Point Pleasant in Mason county by John Charles. Prof. G. P. Grimsley in Volume IV., (page 462) gives the following description of the quarry:

Charles Quarry at Point Pleasant, Mason County.

"John Charles has operated from time to time for local use, a small quarry one-fourth mile southeast of the Baltimore and Ohio station at Point Pleasant. The original quarry was opened over 20 years ago. The sandstone when freshly quarried is blue in color, weathering in the exposed parts of the quarry to a buff color. It is filled with mica and has a foliated structure. The stone breaks in small blocks suitable for foundation work.

"The sandstone outcrop comes 10 to 12 feet above a small coal blossom which is 75 to 80 feet above the Great Kanawha river and represents the Pittsburg coal outcrop so that the quarry rock would be the Upper Pittsburg sandstone.

"**Quarry.** The face of the quarry along a fairly smooth joint plane runs east and west. A section shows the following ledges:

	Ft.
Sandy shales and clay	2
Shaly sandstone	5
Buff sandstone	4
Red and brown shales	9
Buff and blue sandstone	15

"The four-foot ledge of buff sandstone is honey-combed through weathering. The lower 15 foot ledge in a portion of the quarry is divided near the center by one foot of blue shales, but this parting disappears as the stone is followed to the west."

The Pittsburgh Coal.

The Pittsburgh coal is the lowest and last measure of the Monongahela series and is the most valuable and important from an economic standpoint in the Appalachian Basin.

It derives its name from the city of Pittsburgh where it crops high up in the river hills and was named by J. P. Lesley in 1856.

A few sections illustrating the structure of the Pittsburgh coal in the Jackson-Mason-Putnam area as measured by the writer will now be given:

Spilman Section Mason County.

	Ft.	In.	Ft.	In.
Sandstone, massive.				
Slate	2	0		
Coal	0	4		
Slate	1	1		
Laminated coal and slate	2	0		
Slate	0	8		
Coal and slate, laminated	0	6	9	2
Slate	0	2		
Impure coal	0	6		
Slate	0	½		
Coal	3	10½		

A section measured in a mine of the Otto-Marmet Coal Mining Company, Raymond City, Pocatalico district, Putnam county, is as follows:

	Ft.	In.	Ft.	In.
Sandstone roof.				
Slate	1	6		
Bone coal	0	5		
Slate	0	2		
Bone coal	0	4		
Slate	0	3		
Coal and slate mixed	0	6		
Slate	0	1	9	3
Coal, Moonshine	1	0		
Draw slate	0	6		
Bone coal	0	2		
Coal	5	6		
Bone coal	0	4		

In the above section the 5 feet and 6 inches stratum is all that is mined. The coal and slate above this stratum are left in the roof and the bone coal on the floor of the mine is left to protect the mine from the stratum of soft fire clay which underlies this seam of coal. This fire clay when exposed to the atmosphere and becomes moistened forms a very soft floor.

N. E. Smith Core Drill Hole.

The following is the record of the N. E. Smith core drill hole (P-25) located on Salt Lick creek, Pocatalico district, Putnam county, the data being furnished the Survey by Thos. E. Donovan, Washington, Pa.:

	Thickness. Feet.	Total. Feet.
Conductor	14	14
Gray rock	15	29
Red shale	15	44
Blue clay (some mica scales)	1	45
Blue rock	12	57
Red rock	19	76
Gray rock	24	100
Red rock	25	125
Gray sandstone	30	155
Blue soapstone	5	160
Blue shale	10	170
Dark red shale	9	179
Blue shale	7	186
Dark red shale	3	189
Blue clay, tough .... 15′ } Pittsburgh		
Sandstone .... 10′ } Sandstone	25	214
Coal, Pittsburgh	?	
Dark fire clay		
Sandstone		

The Pittsburgh sandstone in this hole appears to have been displaced by blue and red shale and is not massive.

The thickness of the Pittsburgh coal is not given, but it is more than probable this seam is still thick enough to be of commercial value.

The following is the record of a core drill hole (P-27) located on Eighteen Mile creek, Union district, Putnam county, put down by Messrs. Abney and Humphreys of Charleston, West Virginia; elevation 620' A. T. Aneroid:

Eighteen Mile Creek Boring.

	Thickness.		Total.	
	Ft.	In.	Ft.	In.
Surface	13	8	13	8
White sandstone	2	10	16	6
White soapstone	12	1	28	7
Mixed white soapstone	14	7	43	2
Red soapstone	0	8	43	10
Red soapstone, occasionally blue	15	0	58	10
Red soapstone	0	5	59	3
White soapstone	9	3	68	6
Red soapstone	4	5½	72	11½
Red soapstone	2	3½	75	3
White soapstone	6	9	82	0
Red soapstone	1	8½	83	8½
Red soapstone	1	3½	85	0
White soapstone	4	11½	89	11½
Red soapstone (brown and blue)	4	3½	94	3
Bluish white soapstone	11	11½	106	2½
Red soapstone	3	..	109	2½
White soapstone	1	..	110	2½
Red soapstone	12	..	122	2½
Red soapstone	12	8	134	10½
White soapstone	12	1½	147	..
Bluish soapstone	25	7½	172	7½
Red soapstone	3	5½	176	1
White soapstone	8	3½	184	4½
Red soapstone	1	5½	185	10
Bluish white soapstone	45	3½	231	1½
Sandstone, blue and white	3	0	234	1½
Grayish white soapstone	6	6	240	7½
Gray sandstone	17	4	257	11½
Gray sandstone	5	11	276	1½
Blue soapstone	2	9	278	10½
Gray sandstone	4	..	282	10½
Black slate	1	1	283	11½
Pittsburgh coal: Coal 0' 5"; Black slate 3 8½; Gray slate 0 7; Coal 0 6; Black slate 2 2½; Coal 0 1	7	6	291	5½

In the above section the Pittsburgh bed holds its thickness but has been displaced with a black slate. This is

characteristic of this seam in the Raymond City field, as this black slate was encountered in the Raymond City Mine and it was necessary to drive entry more than 3000 feet to get through the slate into the coal.

Prichard Core Drill Hole.

The following is the record of the core drill hole (P-40), put down by the Plymouth Coal & Mining Company, Plymouth, West Virginia, on the Prichard farm in Pocatalico district, Putnam county; elevation of surface, 655′ A. T. Aneroid;

	Thickness.		Total.	
	Ft.	In.	Ft.	In.
Clay and sand	8	6	8	6
Clay	3	0	11	6
Red shale	4	6	16	0
Blue soapstone	19	3	35	3
White sandstone	3	0	38	3
Blue soapstone and sandstone	14	0	52	3
Red and blue shale	5	0	57	3
Blue clay (heavy top)	1	2	58	5
Black slate	1	3	59	8
Sandy fire clay (red)	4	11	64	7
White sandstone	7	4½	71	11½
Blue soapstone	7	4	79	3½
Red shale	4	1	83	4½
Blue soapstone	11	2	94	6½
Red and Blue shale	3	5½	98	0
Blue soapstone	7	0	105	0
Blue soapstone	1	5½	106	5½
White sandstone	9	½	115	6
Dark clay (heavy top)	1	2	116	8
Coal .... 1′ 2″ Slate and coal.... 5′ 0″ } Pittsburgh coal Coal .... ?	6	2	122	10

It will be seen from the record of this hole that the massive sandstone overlying the Pittsburgh coal is also absent, having changed into blue soapstone and red and blue shales.

The R. Harrison Core Drill Hole.

The following is the record of the core drill hole (P-41), put down by the Plymouth Coal & Mining Company on lands of R. Harrison, Left fork of Pocatalico river, at the mouth of

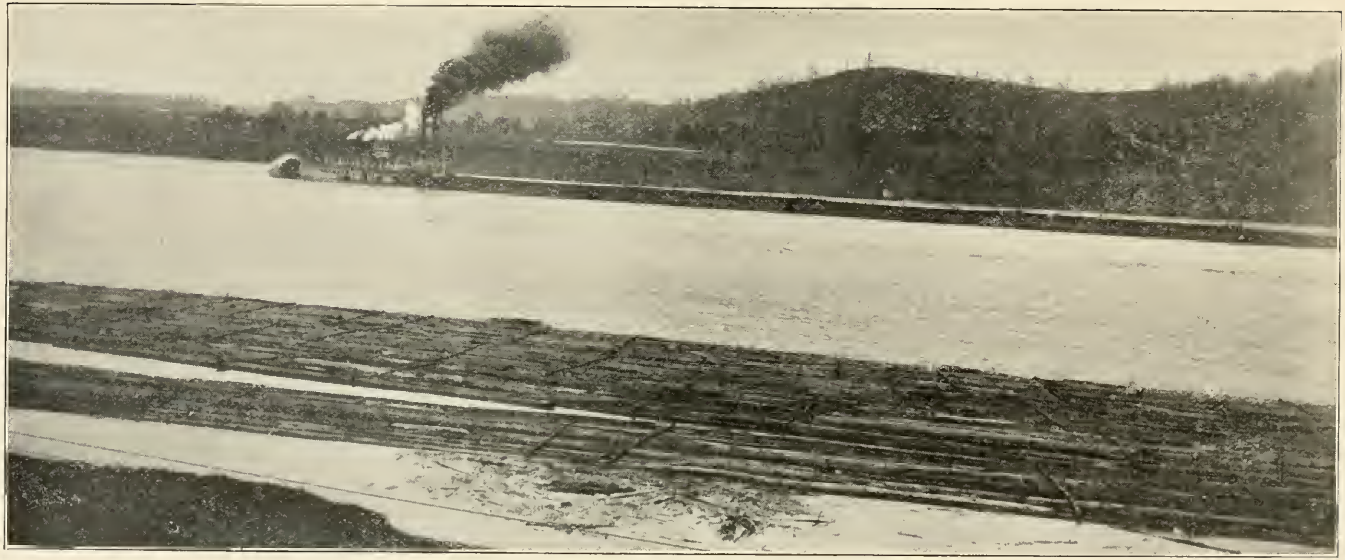


PLATE XVII—Steamer Otto Marmet in Ohio River with Loaded Coal Barges.

Sycamore creek, Pocatalico district, Putnam county; elevation of surface 685′ L.:

	Thickness. Ft.	In.	Total. Ft.	In.
Earth and sand	11	0	11	0
Clay and sandstone	2	3	13	3
Red shale	8	11½	22	2½
Blue soapstone	5	4	27	6½
White sandstone	10	6	38	½
White limestone	20	2	58	2½
Blue soapstone	4	0	62	2½
Red shale	5	0	67	2½
Blue and red shale	3	0	70	2½
Red shale	7	0	77	2½
Blue soapstone	8	8	85	10½
Red shale	1	4	87	2½
Red and blue shale	4	0	91	2½
Blue soapstone and sandstone	10	2	101	4½
Blue sandstone	2	1	103	5½
Blue soapstone	8	1	111	6½
Blue sandstone	3	9	115	3½
Blue sandstone and soapstone	4	0	119	3½
Black shale	5	4	124	7½
Black soapstone and sandstone	12	4	136	11½
Blue soapstone	12	11	149	10½
Blue sandstone and soapstone	15	3½	165	2
Blue sandstone	7	0	172	2
White sandstone	4	4½	176	6½
Blue clay (heavy top) } Pittsburgh	1	6	178	0½
Coal } Pittsburgh	0	...	...	...
Fire clay } Pittsburgh	2	0	180	0½

The Upper Pittsburgh sandstone overlying the coal which is massive and heavy along the Ohio river seems to have changed in this core drill hole mostly into blue soapstone.

The E. B. Honaker Core Drill Hole.

The following is the record of a core drill hole (P-42) located on Left fork of Poca river, put down by the Plymouth Coal & Mining Company; elevation of surface 718′ A. T. Spirit Level:

	Thickness. Feet.	Total. Feet.
Red clay and boulders	7	7
Red and blue shale	13	20
Blue shale	16	36
Red shale	13	49
Sandstone	3	52
Blue shale	5	57
Sandstone	9	66
Sandy shale	5	71

	Thickness. Feet.		Total. Feet.	
Red shale	22		93	
Sandy shale	9		102	
Sandstone	27		129	
Blue shale	9		138	
Gray shale	4		142	
Red and blue shale	3		145	
Lime shale	7		152	
Sandy shale	2		154	
Sandstone	20		174	
Blue shale	5		179	
Sandstone	4		183	
Blue shale	3		186	
Red shale	2		188	
Blue shale	18		206	
Red shale	5		211	
Blue shale	14		225	
Gray shale	2		227	
Sandstone	7		234	
Sandy shale	3′	6″	237′	6″
Gray shale	1′	6″	239	
Dark shale	3′	10″	242′	10″
Coal, (Pittsburgh)	?			
Fire clay	1′	2″	244′	0
Sandstone	7	0	251′	0

The above hole starts at the top of the Monongahela series and shows the entire absence of all the coals above the Pittsburgh coal. The thickness of the Pittsburgh coal is not given, but it is more than probable that it is of workable thickness at this point.

The Sigman Core Drill Hole.

The following is the record of a core drill hole (P-45) located on Right fork of Pocatalico river, Pocatalico district, Putnam county, near Heizer, put down by the Plymouth Coal & Mining Company; elevation of surface, 664′ A. T. Spirit Level:

	Thickness. Ft.	In.	Total. Ft.	In.
Earth and blue gravel	14	8	14	8
Hard blue sandstone	25	4	40	0
Blue sandstone	10	0	50	0
Blue sandstone and soapstone	30	0	80	0
Red and blue shale	8	0	88	0
Hard blue soapstone	0	10½	88	10½
Blue sandstone	15	4	103	2½
Blue soapstone and sandstone	7	0	110	2½
Blue heavy top, clay	1	6	111	8½
Pittsburgh coal: Top—coal 2′ ½″; Heavy top 1′ 4″; Coal 6′ 6″	9	10½	121	7
Fire clay	..	..	..	..

The Pittsburgh sandstone is broken up in the above hole. The Pittsburgh coal has its usual thickness, showing a seam of clean coal, 6 feet 6 inches thick.

Sycamore Branch Core Drill Hole.

Record of core drill hole (P-44) on Sycamore branch of Left Hand fork of Pocatalico river, put down by Messrs. Abney and Humphreys of Charleston, West Virginia:

	Thickness.		Total.	
	Ft.	In.	Ft.	In.
Concealed	8		8	
Sandstone	5		13	
Red shale	11		24	
White sandstone	8		32	
Blue shale	7	4	39	4
Red shale	0	8	40	
White sandstone	3		43	
Soapstone	6		49	
Red shale	20	3	69	3
White sand rock	20	3	89	6
Red shale	4		93	6
Blue shale	3	3	96	9
Red shale	12		108	9
Blue shale	1	0	109	9
Red shale	1	3	111	
Blue shale	2	7	113	7
Red shale	7	0	120	7
Blue shale	9	6	130	1
Hard red shale	4	0	134	1
Blue shale	5	0	139	1
Red and white sandstone	5	9	144	10
Slate and sandstone	7	0	151	10
Red and blue shale	1	0	152	10
Blue slate and shale	2	8	155	6
Red shale	1	2	156	8
Blue shale and sand	6	2	162	10
Red shale	4	8	167	6
Sand and slate	8	1	175	7
Blue slate	3	0	178	7
Brown slate	3	2	181	9
Sandy shale	5	5	187	2
White sandstone	4	8	191	10
Brown and red shale	4	1	195	11
Brown shale	7	6	203	5
Gray sand rock	15	0	218	5
Blue soapstone	2	0	220	5
White sandstone	1	6	221	11
Blue shale	9	3	231	2
Gray shale	10	2	241	4
Sandstone and shale	4	5	245	9
Coal (Pittsburgh)	1	6	247	3

	Thickness. Ft.	In.	Total. Ft.	In.
Sandstone	0	6	247	9
Slate and sandstone	7	10	255	7
Sandstone	9	2	264	9
Sand and slate	2	0	266	9
Red shale	4	0	270	9
Blue shale	5	11	276	8
Brown shale	11	8	288	4
Brown shale and sandstone	7	11	296	3
Soft sandstone	1	0	297	3
Red shale	3	2	300	5
Brown shale	1	0	301	5
Red shale	3	2	304	7
Black sandy shale	10	2	314	9
Black and red shale	16	8	331	5

This well starts near the horizon of the Waynesburg coal and extends to a depth of 93 feet below the Pittsburgh coal.

The Little Pittsburgh coal appears to be entirely absent here.

Farrar Core Drill Hole.

Record of the Farrar core drill hole (P-47), located on Low Gap fork of Left fork of Pocatalico river, Pocatalico district, Putnam county; record furnished the Survey by Thomas E. Donovan, Washington, Pennsylvania:

		Thickness. Ft.	In.	Total. Ft.	In.
Earth		3	6″	3	6″
Sandstone		2	6	6	
Blue shale		11		17	
Red shale (water)		2		19	
Blue shale		9		28	
Hard red sandstone		26		54	
Blue shale		7		61	
Light gray sandstone		19		80	
White shale		1		81	
Gray sandstone 9′					
Dark sandstone 4′					
Reddish, dark sandstone. 5′					
Grayish, dark sandstone. 4′					
Light sandstone 6′					
Reddish, dark sandstone. 3′	Pgh. Sandstone	72	6	153	6
Gray, sandy shale 12′					
Gray sandstone 6′					
Light sandstone 9′					
Dark sandstone 4′					
Fine, gray sandstone 10′ 6″					
Coal, Pittsburgh		?			

The thickness of the Pittsburgh coal is not given, but it is possible that it is thick enough to be of commercial value.

The following is the record of a core drill hole (P-46) on Bailey branch of Pocatalico river, Pocatalico district, Putnam county, put down by Messrs. Abney and Humphrey of Charleston, West Virginia:

	Thickness.		Total.		
	Ft.	In.	Ft.	In.	
Surface	12	6	12	6	
Red slate	7	0	19	6	
Blue slate	4	6	24	0	
White sandstone	19	9	43	9	
Blue slate	5	0	48	9	
White sandstone	28	11	77	8	
Soapstone	18	9	96	5	
White sandstone	6	0	102	5	79′ 7″
Red slate	3	0	105	5	
Sandstone	22	11	128	4	
Black slate	21	9	150	1	
Brown slate	1	0	151	1	
Coal, Pittsburgh	3	8½	154	9½	
White sandstone	2	0	156	9½	

The fire clay usually present below the Pittsburgh coal appears to be replaced with a white sandstone.

Long Hollow Core Drill Hole.

The following is the record of a core drill hole (P-48) on Long Hollow of Right fork of Pocatalico river, put down by the Plymouth Coal & Mining Company: elevation of surface, 730′ A. T. (Aneroid):

	Thickness.		Total.	
	Ft.	In.	Ft.	In.
Brown earth and clay	4	0	4	0
Blue soapstone	7	0	11	0
Red shale	16	5	27	5
Blue soapstone and sandstone	15	0	42	5
White sandstone	18	0	60	5
Blue soapstone	5	4	65	9
Red shale	2	6	68	3
Blue soapstone	6	3	74	6
Red shale	3	0	77	6
Blue soapstone and sandstone	13	2	90	8
Red shale	2	4	93	0

	Thickness. Ft.	In.	Total. Ft.	In.
Blue sandstone	12	0	105	0
Blue soapstone	28	6	133	6
Red shale	1	4	134	10
Blue soapstone	2	8	137	6
Red shale	0	7	138	1
Yellow shale	0	6	138	7
Red shale	1	2	139	9
Yellow shale	0	8	140	5
Blue soapstone and sandstone	4	1	144	6
Red shale	1	0	145	6
Blue soapstone and sandstone	4	6	150	0
Red shale	1	2	151	2
Blue sandstone	24	5	175	7
White sandstone	24	6½	200	1½
Blue heavy top	0	8	200	9½
Coal (Pittsburgh)	?			
Fire clay	8	8		
Blue sandstone	6	7		

The Pittsburgh sandstone shows a thickness of 48 feet 11½ inches in this hole. The thickness of the Pittsburgh coal is not given.

The Smith Heirs Core Drill Hole.

The following is the record of a core drill hole (P-49) located on property of the Smith heirs, Salt Lick creek of Eighteen Mile, Pocatalico district, Putnam county, put down by the Plymouth Coal & Mining Company; elevation of surface, 745′ A. T. (Aneroid):

	Thickness. Ft.	In.	Total. Ft.	In.
Red clay and boulders	10	0	10	0
Red and blue shales	6	0	16	0
Sandstone	14	0	30	0
Red shale	15	0	45	0
Sandstone	10	0	55	0
Red shale	3	0	58	0
Blue shale	2	6	60	6
Sandstone and shale	5	0	65	6
Red shale	3	6	69	0
Red shale	8	0	77	0
Shale, conglomerate	3	0	80	0
Sandstone	14	0	94	0
Red and blue shale	12	0	106	0
Red shale	18	0	124	0
Blue shale	3	0	127	0
Sandstone	15	0	132	0
Sandstone	7	0	139	0
Red and blue shale	20	0	159	0

PLATE XVIII—Tipple and Fleet of Plymouth Mining Company, Plymouth, Putnam County.

	Thickness. Ft.	In.	Total. Ft.	In.
Lime shale	3	0	162	0
Red and blue shale	13	0	175	0
Red shale	5	0	180	0
Gray shale	5	0	185	0
Red shale	3	6	188	6
Gray shale	5	6	194	0
Sandy shale	4	0	198	0
Gray shale	4	6	202	6
Red shale	1	6	204	0
Gray shale	9	0	213	0
Sandstone	5	0	218	0
Gray shale	3	0	221	0
Sandstone	33	0	254	0
Gray shale	3	0	257	0
Sandstone	5	0	262	0
Soft gray shale	1	3	263	3
Coal, Pittsburgh	?			
Fire clay	1	1		

The above core drill hole starts near the top of the Monongahela series, but no coal is found until the Pittsburgh seam is reached.

Honaker Core Drill Hole.

The following is the record of a core drill hole (P-50) located on land of Mr. Honaker, Buck Lick run of Eighteen Mile creek, Union district, Putnam county, put down by the Plymouth Coal & Mining Company; elevation of surface, 705′ A. T. (Aneroid):

	Thickness. Ft.	In.	Total. Ft.	In.
Red clay and boulder	4	0	4	0
Sandstone (Gilboy)	19	0	23	0
Soft blue shale	6	0	29	0
Red shale	3	0	32	0
Sandstone	20	0	52	0
Blue shale	8	0	60	0
Red shale	21	0	81	0
Blue shale	2	0	83	0
Sandstone	28	0	111	0
Blue shale	5	0	116	0
Sandstone	14	0	130	0
Blue shale	1	0	131	0
Red shale	9	0	140	0
Blue shale	4	0	144	0
Gray sand shale	26	0	170	0
Sandstone	17	6	187	6
Blue shale	6	6	194	0

	Thickness. Ft.	In.	Total. Ft.	In.
Sandstone	17	0	211	0
Gray shale	2	0	213	0
Sandstone	14	0	227	0
Gray shale	9	4	236	4
Coal, Pittsburgh	?			
Fire clay	4	0		
Blue sandstone	9	0		

The Pittsburgh sandstone seems to be getting thicker and heavier at this point as shown in the section above, but still holds some shale mixed in with the same.

Parke Raines Core Drill Hole.

The following is the record of a core drill hole (P-51) located on land of Parke Raines, Eighteen Mile creek, Union district, Putnam county; elevation of surface, 600′ A. T. (Spirit Level):

	Thickness. Ft.	In.	Total. Ft.	In.
Red clay and sandstone (Waynesburg)	23	0	23	0
Red shale	10	0	33	0
Gray shale	16	0	49	0
Sandstone	5	6	54	6
Blue shale	1	6	56	0
Sandstone	1	0	57	0
Blue shale	6	0	63	0
Red shale	7	0	70	0
Blue shale	6	6	76	6
Red shale	1	6	78	0
Blue shale	3	0	81	0
Sandstone	15	0	96	0
Red shale	16	0	112	0
Sandy shale	8	0	120	0
Red shale	12	0	132	0
Red and blue shale	10	0	142	0
Red shale	0	6	142	6
Blue shale	2	0	144	6
Red shale	9	0	153	6
Sandstone	7	0	160	6
Red shale	2	0	162	6
Blue shale	7	0	169	6
Sandy shale	4	0	173	6
Sandstone	36	0	209	6
Gray shale	2	0	211	6
Lime shale	5	0	216	6
Black shale	1	0	217	6
Blue shale	2	0	219	6
Sandy shale	9	0	228	6
Sandstone	38	0	266	6
Gray sandy shale	8	0	274	6

		Thickness. Ft.	In.	Total. Ft.	In.
Dark shale and coal..1′ 6″ Coal ....0′ 4″ Dark shale and coal..1′ 2″ Dark shale ....1′ 5″ Dark coaly shale.....0′ 7″ Dark shale ....2′ 8″	Pittsburgh Coal, roof.......	7	8	282	2
Coal		?			
Fire clay		1	3		

The above core drill hole begins at the top of the Monongahela series and shows the usual absence of all the coals above the Pittsburgh. The thickness of the Pittsburgh coal is not given, but it is possibly thinning out as we approach the norther edge of Putnam county.

James L. McLain Well No. 1.

The following is the record of well No. 1 (P-61) located on lands of James L. McLain, Union district, Putnam county, drilled by the United Fuel Gas Company; well completed December, 1910; elevation of surface, 715′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Conductor	13	13	Monongahela Series. 255′
Slate	10	23	
Red rock	20	43	
Lime	20	63	
Red rock	30	93	
White slate	50	143	
Lime	20	163	
White slate	70	233	
Red rock	17	250	
Coal (Pittsburgh)	5	255	
Slate	20	275	Conemaugh Series. 555′
Red rock	50	325	
White shale	50	375	
Red rock	90	465	
Black shale	60	525	
Red rock	50	575	
White slate	65	640	
Dark sand	110	750	
Black slate	45	795	
Lime	15	810	

	Thickness. Feet.	Total. Feet.	
White slate	25	835	Allegheny Series. 229′
1st Salt sand	35	870	
White slate	60	930	
2nd Salt sand	60	990	
Coal, Lower Kittanning?	9	999	
Black slate	40	1039	
Lime	21	1060	Pottsville Series. 601′
Black slate	40	1100	
Lime	25	1125	
White slate	50	1175	
Sand	25	1200	
Lime	50	1250	
White slate	40	1290	
Sand	35	1325	
Black slate	50	1375	
Sand	25	1400	
Black slate	75	1475	
Sand	10	1485	
Slate	15	1500	
Sand	140	1640	
Slate	2	1642	Mauch Chunk. 15′
Lime	8	1650	
Pencil cave	5	1655	
Lime (Big Lime)	125	1780	
Sand (Keener)	30	1810	
White slate	20	1830	
Sand (Big Injun)	70	1900	
Slate	5	1905	
Sand, "Squaw"	27	1932	
Sand and lime	200	2132	
Black slate	50	2182	
Sand	11	2193	
Slate	133	2326	
Sand (Berea)	16	2342	
Slate	33	2375	

This well starts near the top of the Monongahela series and goes through the Berea sand. The record shows that the distance from the bottom of the Pittsburgh coal to the top of the Berea sand at this point is 2,071 feet. This record was carefully kept by the driller, Mr. W. B. Heaters, and is very interesting, as it shows the thickness and character of the different series at that point in Putnam county. The "Salt Sands" of the driller at 835′ and 930′ are members of the Allegheny series.

Spring Valley Branch Core Drill Hole.

The following is the record of a core drill hole (P-62) put down by Yawkey and Freeman on Spring Valley branch of Eighteen Mile creek, Union district, Putnam county; elevation of surface, 690′ A. T. (Aneroid):

	Thickness. Ft.	In.	Total. Ft.	In.	
Surface	6	8	6	8	
Gray sandstone	21	5½	28	1½	
Blue soapstone	7	6	35	7½	
Red soapstone	1	10	37	5½	
Blue soapstone	24	2½	61	8	
Red soapstone	8	4	70	0	
White soapstone	2	11½	72	11½	
Red soapstone	2	5½	75	5	
White soapstone	8	2½	83	7½	
Gray sandstone	5	6	89	1½	
Blue soapstone	11	2	100	3½	
Red soapstone	0	10½	101	2	
Blue soapstone	1	0	102	2	Dunkard Series. 135′ 4″
Red soapstone	6	2	108	4	
White soapstone	6	0	114	4	
Red soapstone	10	0	124	4	
Blue soapstone	1	0	125	4	
Red soapstone	0	6	125	10	
White soapstone	2	0	127	10	
Red soapstone	1	0	128	10	
Gray sandstone	6	6	135	4	
Red soapstone	6	0	141	4	
White soapstone	2	6	143	10	
Gray sandstone	17	7	161	5	
Blue soapstone	16	4	177	9	
Blue and red soapstone	79	10	257	7	
Gray sandstone	24	11	282	6	
Blue and red soapstone	79	10	257	7	
Gray sandstone	24	11	282	6	
Blue and red soapstone	55	1	337	7	
Blue soapstone	3	2½	340	9½	
Gray sandstone	11	11½	352	9	Monongahela Series. 267′ 2″
Blue soapstone	2	10½	355	7½	
Dark sandstone	1	3	356	10½	
Red and blue soapstone	14	1½	371		
Blue soapstone	11	9	382	9	
Brown and black slate	1	11½	384	8½	
Black slate	6	6	391	2½	
Coal 0′ 6″					
Black slate 2 1½					
Coal 0 2					
Black slate 0 1					
Coal 0 5 — Pittsburgh Coal	11	3½	402	6	
Black slate 0 3					
Coal 0 8					
Black slate 0 8					
Coal 6 5					
Gray slate	0	9	403	3	

The above core drill hole demonstrates that all the coals above the Pittsburgh seam in the Monongahela series are absent in this region. The Pittsburgh coal appears with its usual roof of coal and slate and reaches a thickness of 6 feet 5 inches of clean coal. This is an interesting section because it carries the Pittsburgh coal of unusual thickness to a distance of nearly 6 miles north from where it is now mined by the Plymouth Coal & Mining Company.

Several prospect holes were put down by R. E. Nash and others in 1906 in the vicinity of Buffalo, Putnam county, for the purpose of prospecting for the Pittsburgh seam of coal. The following is the record of one of these holes which has been furnished the Survey by Mr. Nash:

Ewer Heirs Core Drill Hole.

Record of hole (P-21) drilled on Five and Twenty Mile creek on land of the Ewers heirs; hole completed August, 1906; elevation of surface, 560′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.
Earth	31	31
Gray slate	19	50
Sandy shale with red soapstone streaks	96	146
Sandstone	16	162
Gray slate	4	166
Limestone	6	172
Gray slate	12	184
Sandstone	20	204
Gray slate	22	226
Red shale	75	301
Gray slate	10	311
Red shale	18	329
Sandstone	25	354
Gray slate	15	369
Red shale	40	409
Sandy shale	11	420
Gray and red shale	4	424
Red shale	13	437
Sandstone	9	446

This hole starts below the horizon of the Pittsburgh coal and does not show any coal whatever in the 446 feet of Conemaugh measures penetrated. The boring was made to test for the Pittsburgh coal, the parties not knowing that they

started below the horizon and that this coal is absent in that region.

J. W. Nash Bore Hole.

Record of the J. W. Nash bore hole, drilled on Cross creek, Buffalo district, Putnam county. Hole completed October, 1907. Elevation of surface, 600′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.
Earth	8	8
Red shale	23	31
Sandstone, Pittsburgh	51	82
Fire clay, Pittsburgh coal horizon	2	84
Red shale	36	120
Sandstone	18	138
Light red shale	18	156
Sandy shale	9	165
Sandstone	10	175
Gray slate with soapstone streaks	3	178
Gray slate	10	188
Black slate	1	189
Coal, Little Clarksburg?	?	

The Pittsburgh sandstone in this hole shows a thickness of 51 feet, while the horizon of the Pittsburgh coal is marked with 2 feet of fire clay. The coal in the bottom of the hole is possibly the Little Clarksburg, and while the thickness is not given in the section, yet there is no doubt that only a trace of coal was found.

Messrs. Yawkey and Freeman drilled several core drill holes in Mason county between the Kanawha and Ohio rivers and have kindly furnished the Survey with copies of the records of these core drill holes, which will now be given. This information is of great importance, since it gives the different strata in the Monongahela series throughout the eastern portion of Mason county and also proves conclusively that very little coal exists in the Monongahela series throughout that portion of Mason.

The Kimberling Core Drill Hole.

Record of core drill hole (M-5), located on the William Kimberling farm on Thirteen Mile creek, Union district, Mason county, near Nat Postoffice; elevation of surface, 600′ A. T. (Aneroid); core drill hole completed March, 1907:

	Thickness. Feet.	Total. Feet.	
Earth	15	15	
Hard sandstone	8	23	
Red rock (Waynesburg coal horizon)	6	29	
White shale	5	34	
Blue rock	5	39	
Limestone	8	47	
White shale	5	52	
Red rock	8	60	
White shale	15	75	
Red rock	5	80	
White shale	10	90	Monongahela
Red rock	5	95	Series.
White shale	10	105	251′
Red rock	10	115	
Lime	7	122	
White shale	15	137	
Red rock	19	156	
White shale	30	186	
Blue rock	5	191	
Red rock	25	216	
White shale	15	231	
White sand	15	246	
Fire clay (Pittsburgh coal horizon)	5	251	
Blue lime	25	276	
Fire clay (Little Pittsburgh)	10	286	
Blue sandstone	10	296	
Red rock	5	301	
Blue sandstone	10	311	
Red rock	10	321	
Blue shale	5	326	
Red rock	10	336	
White sandstone	10	346	
Blue shale	5	351	
Red rock	10	361	
White shale	25	386	
Blue rock	30	416	Conemaugh
Blue shale	15	431	Series.
Black shale	1	432	449′
Red rock	14	446	
Sandstone	7	453	
Red rock	5	458	
White shale	30	488	
Red rock	5	493	
White shale	10	503	
Red rock	45	548	
White shale	19	567	
Red rock	15	582	
Sandstone	20	602	
Blue shale	25	627	
White shale	35	662	
Red rock	15	677	
Blue sandstone	10	687	
Fire clay to bottom	13	700	

The John Stone Core Drill Hole.

The following is the record of the John Stone core drill hole (M-7) located on Thirteen Mile creek upon the John Stone farm, Union district, Mason county, at the mouth of Bee run; hole completed May, 1907; elevation of surface 633′ A. T. (Spirit Level):

	Thickness. Feet.	Total. Feet.
Drift	15	15
Shale, red	10	25
Sand	5	30
Red rock	20	50
Sand	5	55
Blue shale	15	70
Red rock	10	80
Blue shale	10	90
Red rock	5	95
Blue shale	15	110
Red shale	10	120
Blue shale (Waynesburg coal horizon)	5	125
Red shale	25	150
Blue shale	10	160
White sand	10	170
Red rock	20	190
Blue shale	10	200
Sand	10	210
Red rock	25	325
Blue shale	5	240
Red rock	25	265
Blue shale	5	270
Red rock	30	300
Sand, blue 20′; Red rock 40′; Sand 15′ } **Pittsburgh sandstone**	75	375
Black slate 10′; Fire clay 1′ } **Pittsburgh coal horizon**	11	386
Blue slate	14	400
Red rock to bottom	10	410

The Pittsburgh coal is represented in this boring by 10 feet of black slate, and the massive sandstone that overlies this bed appears to be broken up to some extent with red shale. The **Waynesburg coal** is entirely absent from the measures in this hole. The abundance of red beds also betokens the paucity of organic material in these sediments.

The George Kapp Core Drill Hole.

The following is the record of the George Kapp core drill hole (M-8) located on Big Spruce of Thirteen Mile creek on the farm of George Kapp, Union district, Mason county; elevation of surface, 605'; core drill hole completed May, 1907:

	Thickness. Feet.	Total. Feet.	
Drift	20	20	Dunkard Series. 100'
Sand	10	30	
Lime water	10	40	
Red rock	20	60	
Shale, blue	10	70	
Sand (water)	30	100	
Red rock	10	110	Monongahela Series. 285'
Shale, sand parting	25	135	
Red rock	30	165	
White lime	10	175	
Sand	5	180	
Red rock	5	185	
Lime	15	200	
Shale, white	10	210	
Red rock	15	225	
Sand	10	235	
White shale	5	240	
Red rock	5	245	
White shale	5	250	
Red rock	15	265	
White shale	30	295	
Red shale	10	305	
Blue shale	30	335	
Red rock	10	345	
Blue shale, sand parting..20' } Pittsburgh White sand ....10' } Sandstone.	30	375	
Pittsburgh coal horizon. { Fire clay	9	384	
Pittsburgh coal horizon. { Slate, black	1	385	
Slate, draw	50	435	Conemaugh Series. 165'
Sand, white	29	464	
Slate, white	45	509	
Fire clay	25	534	
Red rock to bottom	16	550	

The Pittsburgh sandstone is replaced with blue and red shale in this hole and is not so massive as in different places on the outcrop, while the **Pittsburgh coal** is represented by fire clay and black slate. The **Waynesburg coal** also seems to be entirely absent.

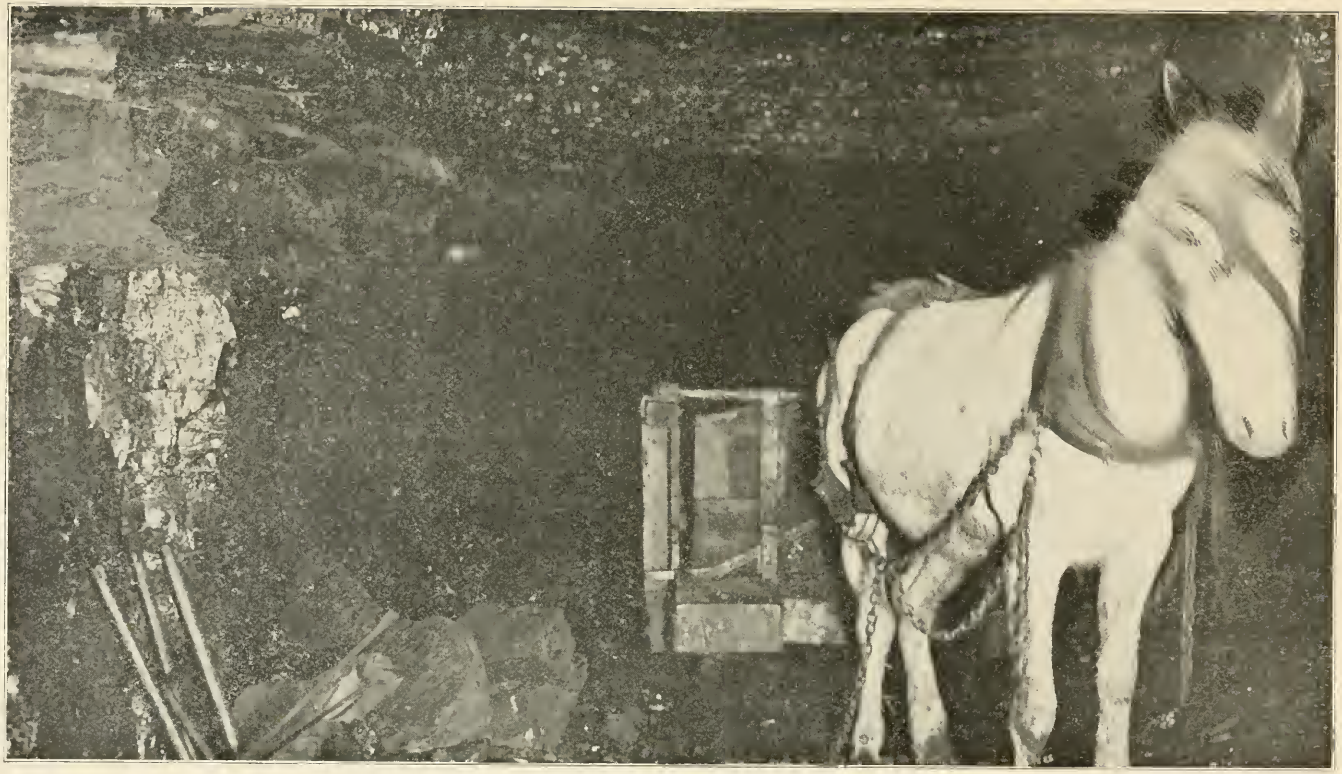


PLATE XIX—Hauling Coal, Plymouth, Putnam County.

The George Smith Core Drill Hole.

The following is the record of the core drill hole (M-9) on land of George Smith, Thirteen Mile creek, Union district, Mason county, one-half mile southeast of Deer Lick; elevation of surface 622′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Drift	15	15	
Blue shale	25	40	Dunkard Series. 110′
Red shale	30	70	
Blue shale	10	80	
Sand (water)	30	110	
Blue shale	25	135	
Red shale	35	170	
Blue shale	35	205	
Red shale	35	240	
Blue shale	40	280	
Red rock	20	300	
Blue shale	5	305	
Sand, gray	18	323	
Fire clay	2	325	
Black shale (Sewickley?)	1	326	Monongahela Series. 281′
Sand, dark, and oil	8	334	
Black slate	1	335	
Slate, sand and clay	10	345	
Blue shale	16	361	
Transparent sand	7	368	
Fire clay	12	380	
Sand	4	384	
Black slate 1′ 0″ } Pittsburgh coal			
Sand 1′ 6″ }			
Black slate 0′ 6″ }	6	390	
Coal 3′ 0″ }			
Slate to bottom	1	391	

This core drill hole is located 3 miles north of the Spring Valley Hole on page 155, and shows a thinning of the Pittsburgh coal from 6 feet 5 inches to 3 feet.

The John Baker Core Drill Hole.

The following is the record of the John Baker core drill hole (M-10) located on Poplar fork of Thirteen Mile creek, Union district, Mason county, on the farm of John Baker; elevation of surface, 600′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Surface	12	12	Monongahela Series. 249′
Red rock	73	85	
Sandstone	5	90	
Red rock	25	115	
Bluestone	15	130	
Red rock	30	160	
Bluestone	20	180	
Red rock	30	210	
Sand and blue stone (Pittsburgh)	34	244	
Slate 1′, Black muck 4′ } Pittsburgh coal	5	249	
Red shale	3	252	Conemaugh Series. 442′
Blue shale	23	275	
Red rock	10	285	
Sandstone	15	300	
Lime	10	310	
Red rock	5	315	
Bluish shale	5	320	
Red rock	5	325	
White shale	20	345	
Sandstone	15	360	
Yellow mud cave (Little Clarksburg coal horizon)	2	362	
Lime	8	370	
Red rock	20	390	
Sandstone	15	405	
Red rock, cave	3	408	
Sandstone	37	445	
Red rock	2	447	
Sandstone	10	457	
Yellow mud, cave, Elk Lick	8	465	
Red rock	35	500	
White lime (Elk Lick)	2	502	
Blue sandstone	18	520	
White shale	10	530	
Limestone (Ames horizon)	8	538	
Draw slate	1′ 6″	539′ 6″	
Blue slate	2	541′ 6″	
Micaceous slate	4′ 6″	546	
Micaceous sand	45	591	
Gray sand	6	597	
Red rock	30	627	
Sandstone	10	637	
Blue stone	5	642	
Draw slate	5	647	
Black slate (Bakerstown coal horizon)	5	652	
Draw slate	5	657	
Blue lime	15	672	
Sandstone (Buffalo)	19	691	

The Pittsburg sandstone does not show up massive in this core drill hole, but is displaced to some extent with red shale, while the Pittsburgh coal is only represented with black

muck and slate. This hole also shows that the coal of the Conemaugh series is entirely absent throughout this region since it extends 442 feet below the Pittsburgh coal horizon.

The Bird Stone Core Drill Hole.

The following is the record of the Bird Stone core drill hole (M-11) located on Rock fork of Thirteen Mile creek, Cologne district, Mason county, one-half mile northeast of Waterloo on land of Mr. Bird Stone; elevation of surface 565′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Surface, drift	16	16	Monongahela Series. 162′
White clay, fire	14	30	
Red shale	30	60	
Light shale	5	65	
Coarse white sand ......25′ / Red shale ......25′ / Gray sand ......30′ — Pittsburgh Sandstone	80	145	
Red rock	15	160	
Black shale and clay (Pittsburgh coal)	2	162	
Blue shale	3	165	
White fire clay	55	220	
Blue shale	20	240	
White fire clay	5	245	
Very white fire clay	20	265	
Red rock	33	298	
White fire clay	19	317	
Sand rock, white mica specks	3	320	
Blood red rock	14	334	
Draw slate	16	350	
Darker slate	10	360	
Red rock	22	382	

The Pittsburgh coal seems to be entirely absent in this hole and only represented by some black shale and clay, while the Pittsburgh sandstone is broken up to some extent by red shale, the top portion of the sandstone being very coarse and white, while the lower portion is gray.

The Malissa Absten Core Drill Hole.

The following is the record of a core drill hole (M-35) located on Thirteen Mile creek, Union district, Mason county, one-half mile northeast of Capehart, on land of Malissa Absten; elevation of surface, 600′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Drift ....35′ } Waynesburg sandstone Sand ....16′ }	51	51	Dunkard Series.
Red rock	15	66	Monongahela Series. 300′
Sand	15	81	
Red rock	40	121	
Fire clay	5	126	
Sand	20	146	
Red shale	40	186	
Sand	30	216	
Red rock	25	241	
Sand ....25′ } Pittsburgh sandstone Blue slate ....55′ }	80	321	
White fire clay (Pittsburgh coal horizon)	30	351	
White fire clay	15	366	Conemaugh Series. 95′
Sand	15	381	
Red shale	35	416	
Red shale	5	421	
Blue shale	15	436	
Red rock	10	446	

The Pittsburgh coal is absent here and is represented only by white fire clay, while the Pittsburgh sandstone is represented by a stratum of sandstone 25 feet thick and by blue shale 55 feet thick.

The M. Eddington Core Drill Hole.

The folowing is the record of a core drill hole (M-36) located in Union district, Mason county, on Mud Lick fork of Thirteen Mile creek, one mile northwest of Elmwood upon land of M. Eddington; elevation of surface, 640′ A. T. (Aneroid):

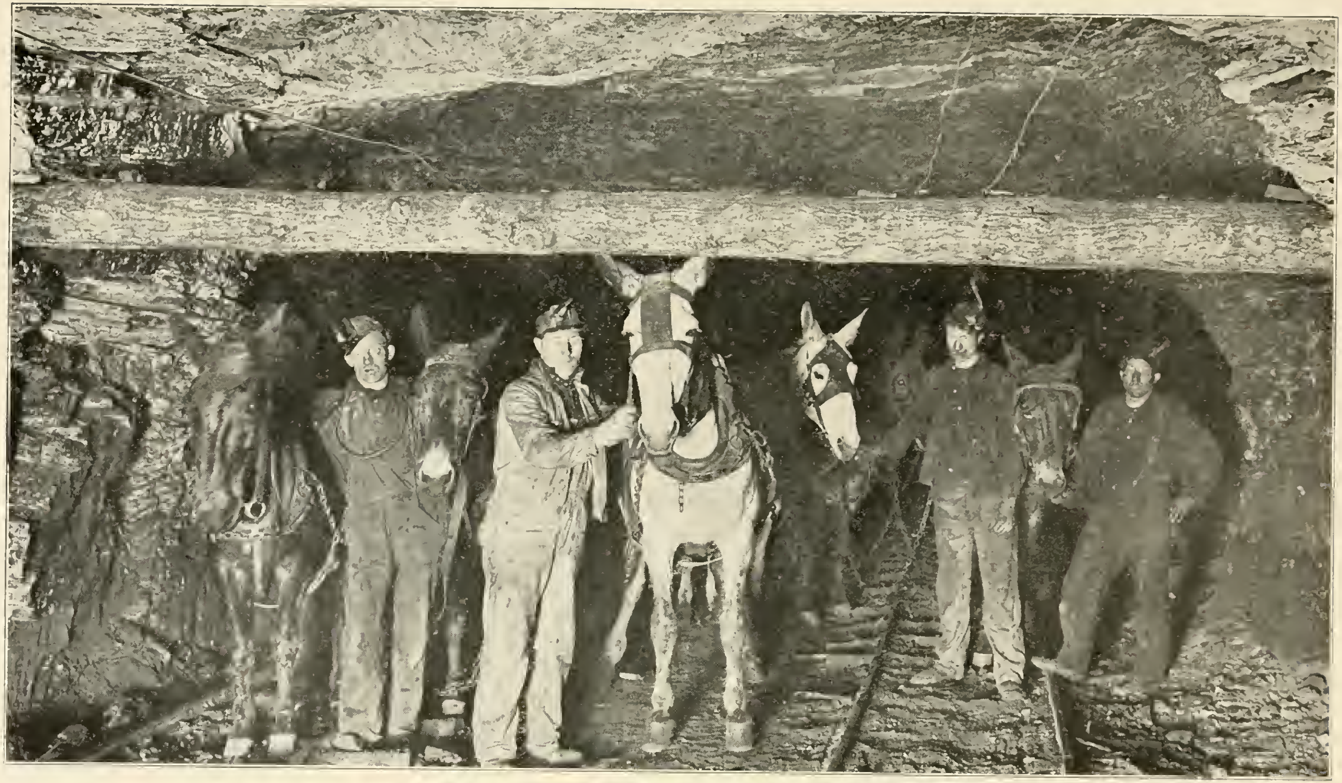


PLATE XX—Passing Siding, Plymouth Coal and Mining Co.

	Thickness. Feet.	Total. Feet.	
Drift	30	30	Dunkard Series. 80′
Red shale	10	40	
Blue shale ..... 5′ } Waynesburg; Gray sand ..... 35′ } sandstone	40	80	
Red shale	15	95	Monongahela Series. 265′
Blue shale	20	115	
Red shale	25	140	
Blue shale	35	175	
Red shale	25	200	
Blue shale (cased at 208′)	45	245	
Gray shale	25	270	
Shale, blue sand parting	15	285	
Red rock	10	295	
Shale, blue, sand parting	10	305	
Brown rock	5	310	
Sand, black	10	320	
Fire clay	2	322	
Slate, draw	18	340	
Fire clay (Pittsburgh coal horizon)	5	345	
White sand	4	349	Conemaugh Series. 21′
Slate, brown	1	350	
Red rock	10	360	
Shale, blue	5	365	
Red rock	1	366	

The Pittsburgh coal is entirely absent, being represented only by fire clay.

The James Morgan Core Drill Hole.

The following is the record of a core drill hole (M-37) located in Cologne district, Mason county, on Ten Mile creek, one mile west of Rollins; elevation of surface 565′ A. T. (Aneroid):

	Thickness. Ft.	Thickness. In.	Total. Ft.	Total. In.	
Surface (cased, shut out large flow of water)	43	9	43	9	Monongahela Series. 190′ 9″
Shale	10		53	9	
Red rock	17		70	9	
Sand	15		85	9	
Sand	18		103	9	
Blue rock	10		113	9	
Red rock	20		133	9	
Blue shale . 5′; Sandstone . . 20′; White lime . 12′; Sandstone . 5′ } Pittsburgh sandstone (water)	42		175	9	
Light slate, (Pittsburgh coal horizon)	15		190	9	

	Thickness. Ft.	Thickness. In.	Total. Ft.	Total. In.	
Red shale	25		215	9	
Yellow mud (Little Pittsburgh)	5		220	9	
Red rock	10		230	9	
Sand	3		233	9	
Lime	4		237	9	
Red rock, cave	18		255	9	
Blue, red cave	40		295	9	
Brown and red rock, cave	22		317	9	
Sand	2		319	9	
Red rock	8		327	9	
Sand	15		342	9	
Blood red rock	10		352	9	Conemaugh
Blue lime	5		372	9	Series.
Red rock, big cave	25		397	9	341′ 2″
Draw slate	6		403	9	
Limestone (Elk Lick)	9		412	9	
Red rock	15		427	9	
Sand	10		437	9	
Red rock	20		457	9	
Slate	10		467	9	
Red rock	15		482	9	
Sand	15		497	9	
Red rock	5		502	9	
Sand	15		517	9	
Sand, light	14	2	531	11	

The Pittsburgh coal is entirely absent in this core drill hole, while the Elk Lick limestone shows a thickness of 9 feet, 213 feet below the Pittsburgh coal horizon.

The Edward Warner Core Drill Hole.

The following is the record of a core drill hole (M-38) located on Mud Lick fork of Thirteen Mile creek, Union district, Mason county, near Tribble; elevation of surface 620′ A. T. (Aneroid):

		Thickness. Feet.	Total. Feet.	
Drift		15	15	
Blue shale		15	30	
Red shale		20	50	
Blue shale		10	60	Monongahela. Series. 296′
Red shale		20	80	
Sandstone		25	105	
Blue shale		5	110	
Red rock		10	120	
Gray sand		20	140	
Red shale		10	150	
Brown shale		50	200	
Blue shale		25	225	
Blue shale		25	250	
White sand	35′			
Sand	15′			
Blue shale and sand	35′			
Sand	5′	Pittsburgh sandstone 93	343	
"Transparent" sand	3′			
Fire clay		3	346	
Slate and coal (Pittsburgh)		6′10″	352′10″	

Here the Pittsburgh sandstone has reached a thickness of 93 feet and the Pittsburgh coal, including slate, a thickness of 6 feet 10 inches. The Waynesburg sandstone has been displaced with red and blue shale, while the Waynesburg coal is entirely absent. Just what the driller meant by "transparent" sand can only be surmised.

The J. M. Ray Core Drill Hole.

The following is the record of a core drill hole (M-39) located on Mud Lick fork of Thirteen Mile creek, Union district, Mason county, three-fourths mile east of Elmwood on the land of J. M. Ray, and one mile northwest of Edward Warner core drill hole; elevation of surface, 620′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Surface ....14' / White sand ....11' / Red rock ....15' / Sandstone ....10' — Waynesburg sandstone	80	80	Dunkard Series.
Red rock	10	90	Monongahela Series. 274'
Blue shale	5	95	
Sandstone (Gilboy)	20	115	
Red rock, shale	15	130	
White shale	10	140	
Gray sand	20	160	
White shale	5	165	
Red shale	25	190	
White shale	25	215	
Red rock	10	225	
Red shale	20	245	
Slate	10	255	
Red shale	30	285	
Sand, Pittsburgh	30	315	
Fire clay	13	328	
Draw slate	18	346	
Black slate	0'6"	346'6"	Pittsburgh coal. 8'
Coal	2	348'6"	
Black slate	0'6"	349'	
Coal	0'6"	349 6"	
Black slate	1	350'6"	
Coal	3'6"	354	
Light slate	30	384	Conemaugh Series. 32'
Sand	2	386	

In this section the Pittsburgh sandstone is broken up and replaced with a stratum of fire clay 13 feet thick. The structure of the Pittsburgh coal seems to be similar to that in some of the places where this coal is mined, having the usual slate overlying the coal and slate partings above the main coal seam.

The McClain Core Drill Hole.

The following is the record of a core drill hole (M-40) located on Road fork of Buzzard creek of Thirteen Mile, Union district, Mason county, on land of McClain; elevation of surface, 675' A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Surface	12	12	Dunkard Series. 120'
Red rock and shale	8	20	
Blue shale	10	30	
Red shale	30	60	
Red shale	10	70	
Light sand ....30' / Light sand ....20' — Waynesburg sandstone	50	120	

	Thickness. Feet.	Total. Feet.	
Blue shale	15	135	Monongahela Series. 275′
Blue rock	5	140	
Red shale	15	155	
Blue shale	10	165	
Red shale	50	215	
Red rock	30	245	
Bluestone	15	260	
White sand	20	280	
Blue rock	20	300	
White shale	30	330	
Blue sand ....45′ } Pittsburgh			
Blue shale ....20′ } sandstone	65	395	
Red rock	15	410	Conemaugh Series. 155′
Blue slate	25	435	
Red rock	20	455	
Draw slate	10	465	
Light fire clay	10	475	
Blue slate	5	480	
Red rock	35	515	
Red shale	5	520	
Red rock	30	550	

This core drill hole is located four miles southwest of the J. M. Ray core drill hole and shows the entire absence of the Pittsburgh coal.

Several years ago Mr. James Hensley of Hartford, Mason county, prospected the territory through the portion of Mason county south of Hartford with core drill holes. He has kindly furnished the Survey with a complete record of these borings. This information is very valuable, in that it gives the thickness of the different strata and also shows the thickness and character of the Pittsburgh sandstone and the Pittsburgh coal. The Survey is greatly indebted to Mr. Hensley for this valuable information.

A few of the records of these core drill holes will now be given:

The B. J. Lerner Core Drill Hole.

The following is the record of the core drill hole (M-18) located on Sliding Hill creek, Graham district, Mason county, two miles south of Hartford on lands of B. J. Lerner; elevation of surface, 590′ A. T. (Aneroid):

	Thickness. Ft.	In.	Total. Ft.	In.	
Surface	20		20		
Coal (Pittsburgh)	5		66	6	Monongahela
Sandstone, Pomeroy	37		57		Series. 66′6″
Black slate	4	6	61	6	
Fire clay	7	3	73	9	
Red shale	4	5	78	1	
Green shale	12	5	90	6	
Red shale	16	0	106	6	
Fire clay	6	5	112	11	
Coal (Little Pittsburgh)	1	7	114	6	
Fire clay and shale	15		129	6	
Red shale	3		132	6	
Green shale	8		140	6	
Red shale	1		141	6	
Sandstone, Connellsville (oil)	7		148	6	
Green shale	5		153	6	
Red shale and fire clay	42		195	6	
Blue shale	8	9	204	3	
Fire clay	4	6	208	9	
Sandstone	6		214	9	
Blue shale	10	6	225	3	
Red fire clay	14	6	239	9	
Green shale	16		255	9	
Sandy shale	12		267	9	
Fire clay	6		273	9	Conemaugh
Dark shale	38		311	9	Series.
Dark slate	14		325	9	546′ 5″
Coal (Harlem?)	0	2	325	11	
Shale and fire clay	16		341	11	
Red fire clay	10		351	11	
Green shale	19		370	11	
Red shale	8		378	11	
Red fire clay	13		391	11	
Sandstone	19		410	11	
Fire clay	4	4	415	3	
Sandy shale	29		444	3	
Sand	25		469	3	
Shale	1		470	3	
Coal and slate (Bakerstown)	0	6	470	9	
Red fire clay and soapstone	65		535	9	
Sand	7	2	542	11	
Dark slate	10		552	11	
Red fire clay	19		571	11	
Sandy shale	4		575	11	
Slate	12		587	11	
Sandy shale	12		599	11	
Dark slate	13		612	11	
Slate and coal (Upper Freeport	0	4	613	3	
Sandstone	8	8	621	11	
Black slate	3	8	625	7	Allegheny
Sandstone	3		628	7	Series.
Dark slate	4	4	632	11	28′ 7″
Coal (Lower Freeport)	5	7	638	6	
Hard fire clay	1		639	6	
Sandy shale to bottom	2		641	6	

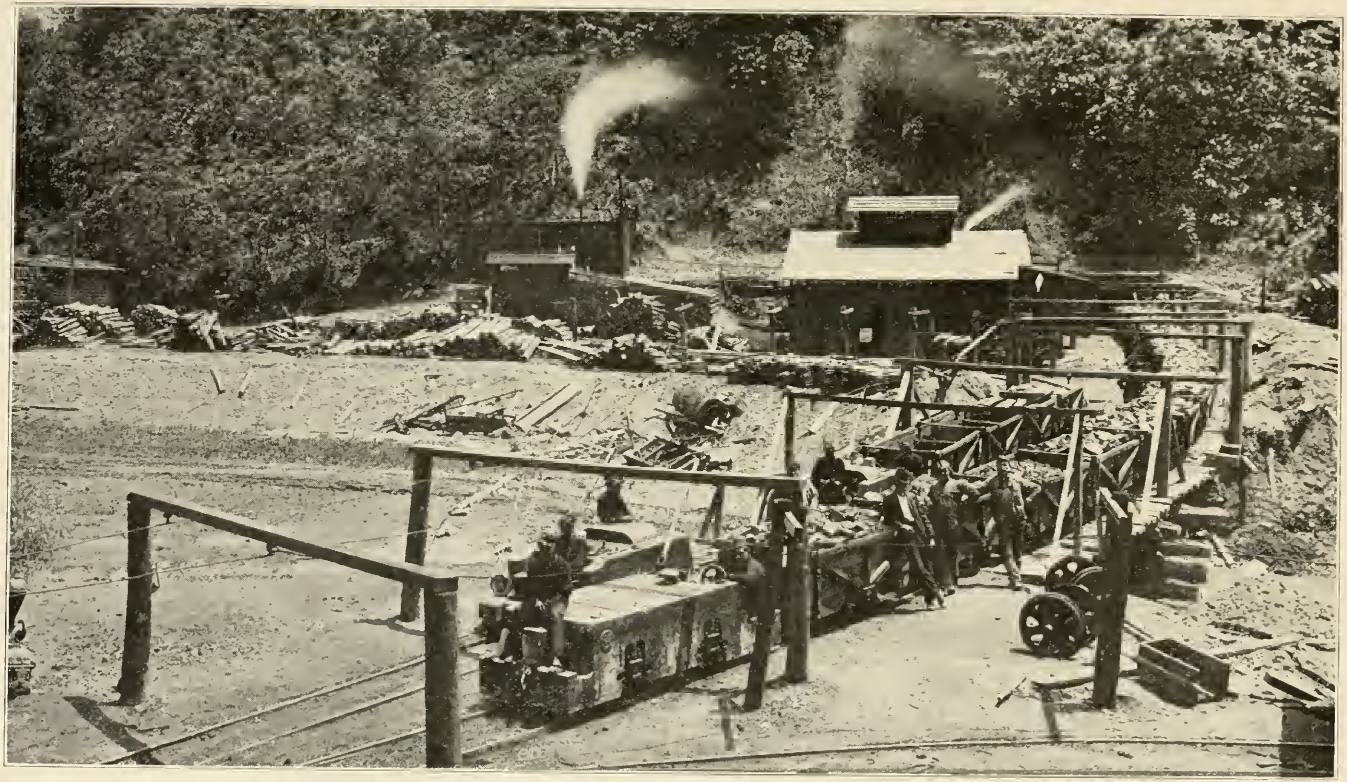


PLATE XXI—Electric Motors. Plymouth Coal and Mining Co., Plymouth, Putnam County.

This hole starts 61½ feet above the Pittsburgh coal and continues through the Conemaugh series into the top of the Allegheny series.

The Frank Rickard Core Drill Hole.

The following is the record of the core drill hole (M-19) located on West creek, Graham district, Mason county, one mile and a half west of Longdale, on lands of Frank Rickard:

	Thickness. Ft.	In.	Total. Ft.	In.
Surface	10		10	
Sandstone	8		18	
Red fire clay	24		42	
Sandy shale	21		63	
Red fire clay	17	7	80	7
Sandstone	47	4	127	11
Dark shale	14		141	11
Carbon ......0'5" Slate ....0'4" Pittsburgh coal 5'3" } Pittsburgh coal	6		147	11

In the above section the Pittsburgh sandstone has reached a thickness of 47 feet 4 inches with 14 feet of slate between it and the coal. The Pittsburgh coal proper shows a thickness of 5 feet 3 inches. The term "carbon" was probably applied to a hard slaty or "black" layer of coal.

The James A. Rayburn Core Drill Hole.

The following is the record of a core drill hole (M-27) located on Old Town creek, Robinson district, Mason county, one mile south of Sassafras, on property of James A. Rayburn; elevation of surface, 665′ A. A. (Aneroid):

	Thickness. Ft.	In.	Total. Ft.	In.	
Surface	10		10		Monongahela Series. 140′
Sandstone	10	8	20	8	
Red fire clay	26	0	46	8	
Sandstone	19	0	65	8	
Soft shale	16	0	81	8	
Red fire clay	23	0	104	8	
Hard shale	13	6	118	2	
Sand	6	0	124	2	
Blue slate	10	10	135	0	
Coal, very hard (Pittsburgh)	5	0	140	0	
Shaly fire clay to bottom	2	0	142	0	

This hole shows the Pittsburgh sandstone to be broken up and replaced for a part of its thickness with red fire clay, while the Pittsburgh coal shows a thickness of 5 feet.

The James McMillian Core Drill Hole.

Record of the James McMillian core drill hole (M-28) located in Robinson district, Mason county, one mile and a half south of Sassafras; elevation of surface, 638' A. T. (Aneroid):

	Thickness. Ft. In.	Total. Ft. In.
Surface	10	10
Light slate	16	26
Soft slate	8	34
Sand	4	38
Light slate	35	73
Red fire clay	16	89
Soft slate	17	106
Sandstone, Pittsburgh	26' 6"	132' 6"
Slate	5' 5"	137'11"
Coal (Pittsburgh)	3' 6"	141' 5"
Slate to bottom	2' 7"	144'

This core drill hole is located one-half mile north of the James A. Rayburn hole, where the Pittsburgh coal shows a thickness of 5 feet, while here the Pittsburgh coal shows a thickness of only 3 feet 6 inches, a thinning of 1 foot 6 inches.

Margaret Roush Core Drill Hole.

A core drill hole (M-16) was put down on the Margaret Roush farm, one mile south of Letart in Cooper district by Messrs. McIntosh & McConnell of Ravenswood, and drilled by the Uniontown Drilling Company. The record was kept by M. J. O'Toole, the driller, and kindly furnished the Survey by Mr. J. E. Barnes of Pittsburgh, Pennsylvania, as published in Volume II (A), page 674; elevation of surface, 560' A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Surface	20	20	Dunkard Series. 93'
White shale	16	36	
Shale	17	53	
Brittle shale	7	60	
Red sand	10	70	
Sandstone, Waynesburg	23	93	

	Thickness. Feet.	Total. Feet.	
Shale	6	99	Monongahela Series. 293′
Sandy shale	9	108	
Shale	30	138	
Limestone	2	140	
Shale	7	147	
Sandy shale	10	157	
Black slate	2	159	
Sandstone	16	175	
Dark slate	3	178	
Fire clay	2	180	
Sandstone	5	185	
Dark slate	2	187	
Sandstone	5	192	
Red shale	2	194	
Sandstone	6	200	
Brittle shale	6	206	
Dark slate	2	208	
Sandy shale	10	218	
Shale	11	229	
Sandy shale	5	234	
Red shale	17	251	
Sandstone	3	254	
Red shale	3	257	
Sandstone	7	264	
Dark slate	5	269	
Brittle slate	49	318	
Sandy shale	9	327	
Sandstone	8	335	
Shale	5	340	
Red shale	7	347	
Sandy shale	10	357	
Shale	20	377	
Brittle shale (Pittsburgh coal)	9	386	
Shale	14	400	
Sandstone, Lower Pittsburgh	51	451	
Brittle shale	12	463	
Sandstone	5	468	
Sandy shale	18	486	
Brittle shale	10	496	
Sandstone	17	513	
Shale	9	522	
Shale	2	524	
Sandstone to bottom	2	526	

The Pittsburgh coal appears to be entirely absent in this section, except as a black slate.

The Upper Pittsburgh sandstone is broken up, while a lower stratum 51 feet thick, the writer has classified as the Lower Pittsburgh sandstone.

In 1860 Daniel Polsley of Point Pleasant, once Lieutenant-Governor of West Virginia, and his son, Weston Polsley,

drilled a well near Letart to a depth of 600 feet in search of salt water. The well was abandoned later as it was not of sufficient depth to reach the salt bearing rocks.

From the sections and the records of core drill holes published in the preceding pages, it will be observed that the coal seam mined in Mason county and the coal seam mined in Putnam county are identical and the same. These core drill holes cover a scope of more than 35 miles in length of the Appalachian Area and cross through the Parkersburg Syncline. While a great many of the core drill holes were only drilled through the Upper or Pittsburgh seam, yet several of them were drilled deeper, some as far as the Upper Freeport bed.

This seam of coal has long been correlated by other geologists as the Pittsburgh bed and the coal that occurs from 20 to 60 feet underneath this one as the Little Pittsburgh. From the study that the writer has made of the area embraced in this volume, he feels no hesitancy in adhering to the previous correlation.

Professor J. A. Bownocker, State Geologist of Ohio, in Bulletin IX, has taken exception to this correlation and he has identified the coal mined at Pomeroy, which is the same seam as the one mined in Mason county, as the Redstone coal. He enters into quite a discussion and gives a great many sections to prove his contentions. The following is in part what he says concerning this seam. (See Bulletin IX, pages 96-106).

The Pomeroy Coal.

"The Pomeroy coal has long been mined in the State of Ohio, its output having been considerably in excess of 400,000 tons in 1906. It is mined in the three counties, Meigs, Gallia and Lawrence, but from the first named only is it shipped in a large way at the present time.

"Andrews classed the seam as the Pittsburgh, and that has heretofore been accepted as correct. Study of this coal in 1907 shows, however, that the seam is not the Pittsburgh but a higher one. It is the equivalent of the Redstone coal of Pennsylvania and West Virginia, and the demonstration of this point is the principal burden of the following pages:

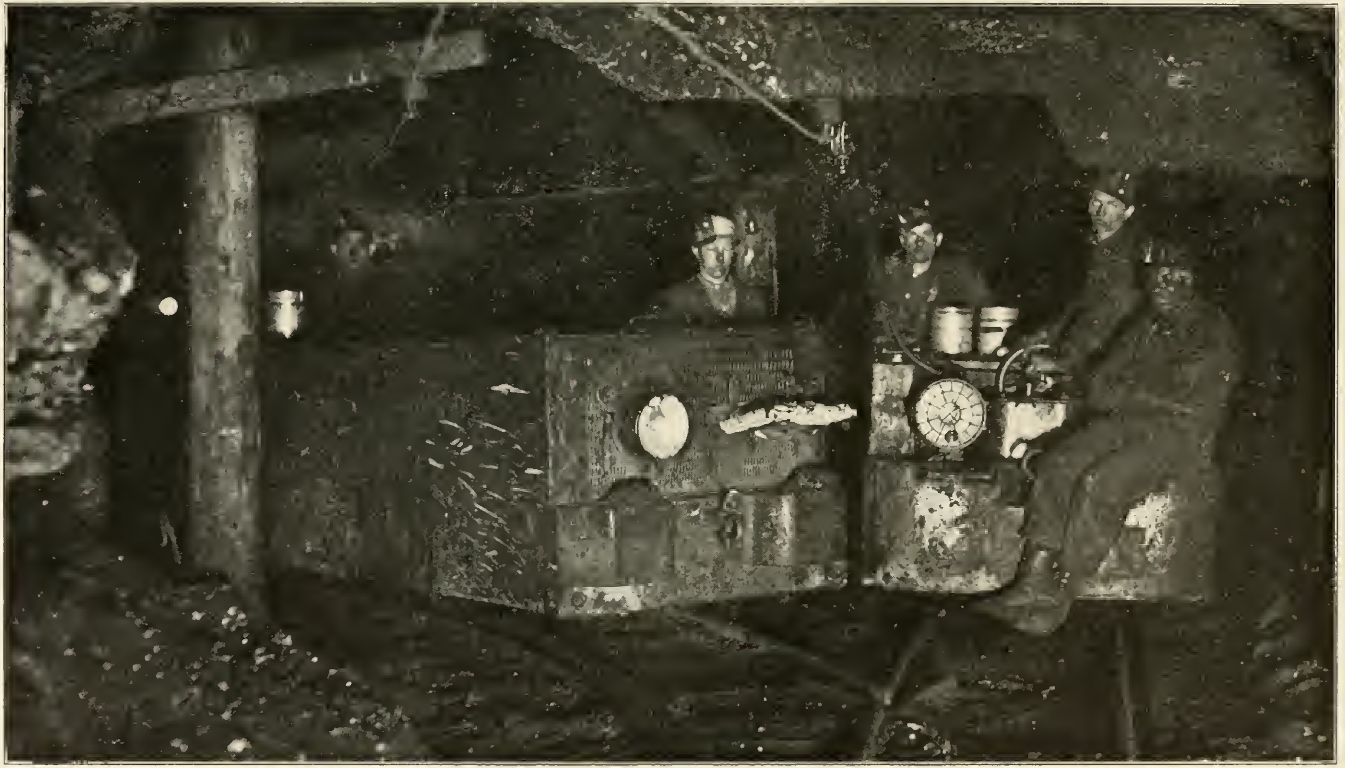


PLATE XXII—Bull-wheel Parting, Plymouth Coal and Mining Co.

Position and Structure of the Redstone Coal in Pennsylvania and West Virginia.

"This seam was named by Rogers from the exposures on Redstone creek, Fayette county, Pennsylvania. It has been identified at numerous places in that State and also in West Virginia, Maryland and Ohio. As will be shown later, its position above the Pittsburgh seam ranges usually from 20 to 55 feet.

"Section on the Beachley farm, near Salisbury, Somerset county, Pennsylvania:

		Ft.	In.
Surface		0	0
Redstone coal	Coal	0	2
	Parting	0	2½
	Coal	0	6
	Parting	0	1
	Coal	2	3
Clay		0	9
Clay, bituminous		0	2
Slate, black, with nodular ore		3	0
Limestone and shale		1	3
Fire clay, impure		1	10
Limestone		10	0
Shales		10	0
Coal reported		3	0
Shale		4	0
Pittsburgh coal		10	0

"The limestone between the two coals is reported to be more conspicuous in this territory than the Redstone coal itself.

The relation of the Redstone coal to the Pittsburgh in West Virginia is shown in the following section on Scott's run, Monongalia county:

	Ft.	In.
Concealed	15	0
Coal, Redstone	4	0
Limestone, Redstone	18	0
Shale and fire clay	5	0
Slate, black	5	0
Coal, Pittsburgh.		

"The structure of the coal in this State is shown by the following section taken in the Century mine in Barbour county:

	Ft.	In.	
Slate.			
Bone coal	0	4	5′ 11⅓″
Coal	5	0	
Slate	0	⅓	
Coal	0	7	

"This coal is found in the hills on both sides of the Ohio river in the vicinity of Wheeling, and has been identified by Dr. I. C. White as the Redstone seam.

The Pomeroy or Redstone Coal From Belmont to Morgan Counties.

"The following section made by Mr. J. E. Hyde about one mile west of Bellaire shows the position and thickness of this seam in the extreme eastern part of the State:

	Ft.	In.
Limestone with shaly layers	4	0
Gray argillaceous shale	3	9
Pomeroy or Redstone coal, No. 8a	1	3
Gray argillaceous shale	0	9
Hard gray amorphous limestone with numerous minute fossils	2	0
Gray shale	0	4
Limestone, hard gray, amorphous with numerous minute fossils	2	3
Limestone, hard gray amorphous with some fossils	2	0
Shales, hard, with some lime and fossils	2	6
Unseen	12	6
Top of Pittsburgh coal No. 8.		

"This section shows thick limestones between the two coals, similar to what have been reported in Pennsylvania and West Virginia. Farther west and southwest in Ohio the limestones are much thinner, but have been traced to the Ohio river at Pomeroy.

"Below is a partial record of a diamond drill test made in section 10 of Wayne township in the southwestern part of Belmont county. Only that part of the record is given which

shows the relative positions of the Pomeroy or Redstone and the Pittsburgh coals:

	Ft.	In.	
Limestone	3	4	
Soapstone with lime nodules	3	0	
Pomeroy or Redstone coal, No. 8a (coal and shale	1	3	
Fire clay	1	0	25′ 4″
Gray shale	3	2	
Black shale	1	0	
Limestone	5	6	
Limestone and shale	2	0	
Limestone	3	0	
Lime, fire clay	2	0	
Gray shale with limestone nodules	3	0	
Greenish shale	1	6	
Dark shale, carbonaceous	3	2	
Pittsburgh coal: Roof coal	0	10	
Pittsburgh coal: Draw slate	1	0	
Pittsburgh coal: Coal	5	7	
Fire clay	4	1	

"Frequent exposures of the seam are found in Jefferson county. The following section was measured by the late Professor C. N. Brown in section 22 of Smithfield township:

	Ft.	In.	
Shales exposed	10	0	
Pomeroy or Redstone coal, No. 8a	2	1	
Clay streak			13′
Limestone	2	0	
Clay shales	11	0	
Pittsburgh coal (roof coal)	2	1	
Draw slate	1	0	
Black slate	0	1	
Pittsburgh coal (breast coal) No. 8	2	4	

"This section shows an interval of only 13 feet between the two seams, while in Belmont county, as the sections shows, the interval is materially larger.

"From Belmont county the coal can be traced southwest through Noble and Morgan counties, but in both of these the exposures of the seam are fewer and less prominent.

"In his report on the Meigs creek coal in the last two counties named in the above paragraph, Professor Brown makes occasional mention of a seam lying between the horizon of the Meigs creek and Pittsburgh coals. Thus in Wayne township in the northeastern part of Noble county, he men-

tions a faint coal mark at from 50 to 55 feet below the Meigs creek. Likewise he speaks of a thin seam of coal about 60 feet below the Meigs creek in Elk township in the southwestern part of the county. The position of the seam is from 20 to 30 feet above the horizon of the Pittsburgh in the localities mentioned and it is plainly the Pomeroy or Redstone coal.

"In the northern part of Meigsville township, Morgan county, Professor Brown found the Pomeroy or Redstone coal from 12 to 20 inches thick about 26 feet above the Pittsburgh seam.

"West of the Muskingum river the Pittsburgh and Pomeroy coals are very thin or wanting until the southwestern part of the county (Morgan) is reached where the Pittsburgh coal suddenly increases in thickness and becomes a workable seam.

Structure of the Pittsburgh Coal in Southwestern Morgan and Northern Athens Counties.

"It will be well at this point to note the structure of the Pittsburgh coal in the territory just referred to where it is commonly known as the Federal creek seam. For the convenience of the reader a few sections will be given which have already appeared in the chapter on the Pittsburgh coal.

"Section of coal in the Waymer bank, near Joy, in the southwestern part of Morgan county:

		Ft.	In.
Coal, Upper bench	Coal	1	6
	Bone coal	0	8
Clay or shales		0	11
Coal, Lower bench	Coal	0	2
	Parting	0	1/8
	Coal	0	7 1/2
	Parting	0	1/2
	Coal	0	3
	Parting	0	3/8
	Coal	0	1 1/2
	Parting	0	3/4
	Coal	2	0

"A few miles farther south in Athens county a number of mines exist, three of which ship by rail. In the one at Broadwell, the coal was found as follows:

Coal, Upper bench	Coal	1	3
	Bone coal	0	3½
	Coal	0	4
Clay or shales		1	0
Coal Lower bench	Coal	0	6
	Parting		
	Coal	0	2
	Parting	0	¼
	Coal	2	5

"These sections are typical for this part of the State. It will be seen that the coal consists of two benches separated by a prominent layer of shales or clay, called soapstone by the miners. This structure of the Pittsburgh seam is very persistent in southern Ohio, and may be found wherever the coal exists in anything like normal thickness. It is further illustrated by sections on the following pages:

The Pomeroy Coal From the Hocking River in Athens County, South to the Ohio River.

"In Alexander township, Athens county, the Pomeroy coal is usually found where due, though frequently it is little more than a blossom. The coal is usually about 20 feet above the Pittsburgh.

"Near the Bennett mine in section 4 of this township, the following section was measured:

	Ft.	In.
Shales, unmeasured.		
Pomeroy coal, No. 8a	1	0
Shales with nodular limestone	20	6
Pittsburgh coal, No. 8	4	0
Shales	8	0
Sandstone, unmeasured.		

"The nodular limestone mentioned in the last two sections is important in the identification of the two coals. It is rarely a foot thick, but is persistent and has been traced to the Ohio

river at Pomeroy where the lower or Pittsburgh coal is not represented by even a black streak. In this part of the State limestones are not common and this fact increases the value of the stratum in question for stratigraphical purposes.

"Lodi township lies east of Alexander and contains the Pomeroy coal where due, the thickness usually ranging from 12 to 18 inches. Occasionally the coal is underlain by several feet of white limestone. The coal is not mined in the township except where it can be stripped.

"Going south from Lodi township, Bedford township, Meigs county is reached. Here the Pomeroy seam is found about 20 feet above the Pittsburgh and about 20 inches thick. It is not mined except by stripping.

"On the Mayhugh farm in section 21, the coal was found as follows:

	Ft.	In.
Coal	0	8
Shales	0	10
Coal	1	8

"On the same farm the lower or Pittsburgh seam has been mined by stripping in the bed of a creek.

"In the southeast corner of this township both coals are well shown and the locality is important in demonstrating the correct position of the Pomeroy seam. About one mile due north of the hamlet of Midway the Pittsburgh coal is stripped in the bed of a run on the Riggs farm, where the following section was measured:

		Ft.	In.
Shales, unmeasured.			
Coal, Upper bench		0	3
Clay or shales		1	3
Coal, Lower bench	Coal	1	0
	Shales	0	1
	Coal	1	6
	Shales	0	1
	Coal	1	6

"It will be noted that the Upper bench here is thin. In fact, where the coal contracts this bench suffers most, and not infrequently disappears. On the hill between this stripping and Midway the upper or Pomeroy coal is found and the thin limestone below it.

PLATE XXIII—Mouth of Mine, Otto Marmet Coal and Mining Co., Raymond City, Putnam County.

"On Kingsbury creek, due south of Midway, the Pittsburgh coal is below drainage, having dipped beneath the bed of that stream about one mile farther up, where the following was measured:

	Ft.	In.
Sandstone, unmeasured.		
Shales	2	0
Pomeroy coal	1	6
Shales, blue	8	0
Shales, with limestone	11	0
Sandstone, shaly	9	0
Pittsburgh coal, unmeasured.		

"A few hundred yards up stream from where this section was taken the Pittsburgh coal has been stripped in the bed of the creek.

"From Kingsbury creek the Pomeroy coal can be followed up a tributary, Peach fork, at least three miles.

"In following up this tributary one crosses from Bedford township into Salisbury which contains the most valuable deposit of the Pomeroy coal above drainage in Ohio. The structure of the seam along Peach fork on the northern edge of Salisbury township is as follows:

		Ft.	In.
Sandstone		30	0
Shale		4	0
Pomeroy Coal	Coal	0	3
	Shale	0	1
	Coal	1	8
Shales		2	0

"The coal has been worked to a very small extent by the farmers. Everywhere along this stream the Pittsburg coal is below drainage and so was not seen. At one place it was reported to have been struck in digging a well, its position being 30 feet below the Pomeroy seam.

"Crossing the divide to the southwest from the head of Peach fork the valley of Ball run is entered and the Pomeroy coal is found in similar position and thickness to that on the first named stream. The position of the coal, immediately under the sandstone, is important.

"Southward on Ball run the coal increases rapidly in

thickness and is mined in a small way at a number of places. It can easily be followed along this stream to the valley of the Ohio. Nowhere in this locality, however, was the Pittsburgh coal found though conditions for its exposure are excellent. In fact, it is not represented by even a black streak. At Pomeroy the persistent band of limestone which has already been referred to was found below the Pomeroy coal.

"The structure as well as the thickness of the Pomeroy coal changes to the south. On the Gilmore farm, north edge of section 28, Salisbury township, on Ball run, the coal was found as follows:

	Ft.	In.
Sandstone	30	0
Coal	1	6
Shales	0	6
Coal	0	4
Clay, unmeasured.		

"On the south side of this section the coal measures 4 feet. Where the coal is thin in Athens and Meigs counties, it is usually divided into two parts by a layer of clay or shales. The structure then resembles that of the Pittsburgh, but as has been shown, the two coals are frequently found on the same hillside and so have not been confused.

The Pomeroy Coal at Pomeroy and Vicinity.

"The structure of the Pomeroy coal at Pomeroy and vicinity forms a marked contrast with that of the Pittsburgh seam in southern Ohio. As has already been shown, the Pittsburgh consists of two prominent benches of coal separated by a layer of shales or clay, this structure being very persistent. The Pomeroy seam on the other hand does not have such a characteristic structure. This is well shown by the following sections:

Section in the Logan Mine, Pomeroy.

	Ft.	In.
Bone and dirty coal	1	3
Coal	1	8
Parting less than ⅛ inch.		
Coal	0	3
Parting very thin.		
Coal	2	3
Clay, unmeasured.		

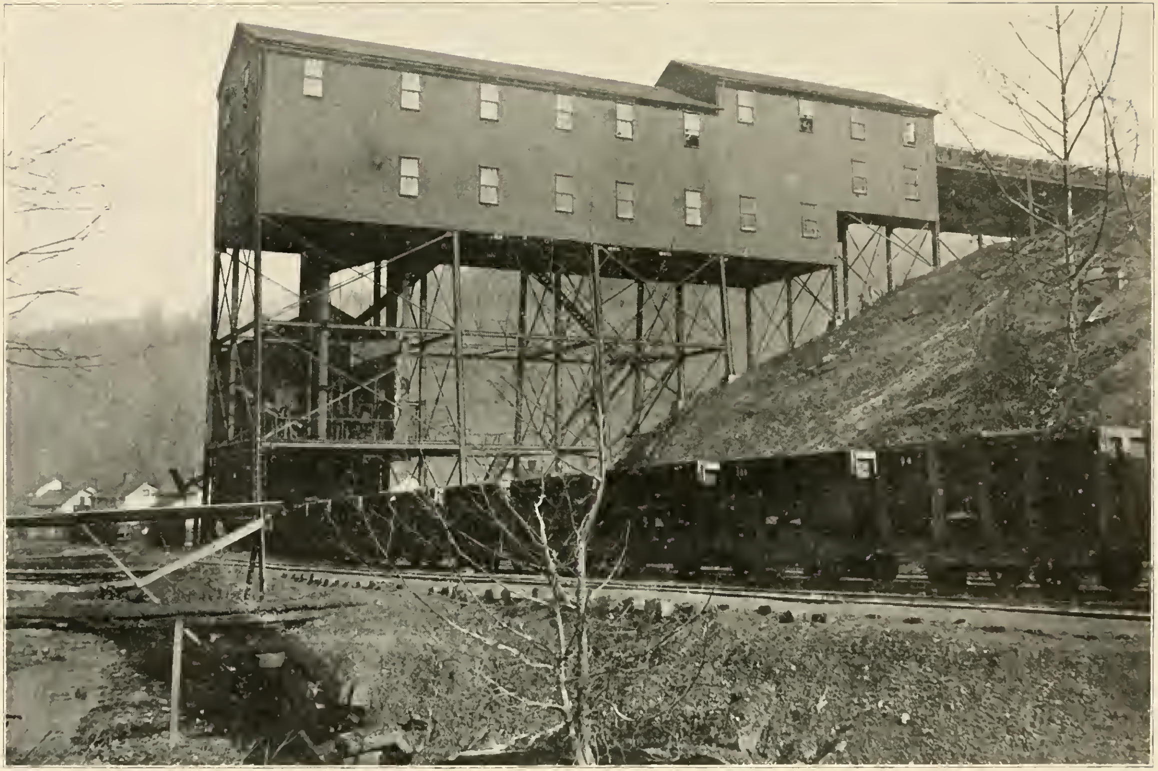


PLATE XXIV—Steel Tipple, Otto Marmet Coal and Mining Co., Raymond City, Putnam County

Section in the Mine of the Peacock Coal Company, Pomeroy.

	Ft.	In.
Shales, reported thickness	2	0
Impure coal	0	6½
Bone coal	0	5½
Coal	3	3

A few miles up the river the coal was found as follows:

Section in the Bartel's Mine, Syracuse.

	Ft.	In.
Sandstone, unmeasured.		
Impure coal	0	7½
Horn coal	0	5½
Coal	1	4
Horn coal	0	2½
Coal	2	3½
Clay, unmeasured.		

"Still farther up the river at Antiquity the coal is mined by shafting, the seam being 100 feet below low water. The coal is as follows:

	Ft.	In.
Coal with a bony band	2	6
Slate	0	2
Coal	3	0

"It may not be amiss to give a section on the West Virginia side of the river. The coal was found as follows in the mine of the West Virginia Salt and Coal Company, near Hartford:

		Ft.	In.
Sandstone.			
Slate.			
Draw slate		0	1
Coal..	Top coal	0	7
	Horn coal	0	2
	Coal	3	9

"Other sections from that side of the river might be given, but they would in a large measure duplicate the above.

"These sections show a marked difference in structure between the Pomeroy coal and the Pittsburgh as found on Federal creek and vicinity, but a striking resemblance to the Redstone coal of Pennsylvania and West Virginia as shown in the first part of this chapter.

The Pomeroy Coal in Gallia and Lawrence Counties.

"In Gallia county, farther west, the structure of the Pomeroy coal becomes more simple, consisting generally of a solid block, but occasionally having one or more shale parting.

"Both the Pittsburgh and Pomeroy coals are found in the eastern part of the western half of Gallia county. Still farther west the Pittsburgh seam wholly disappears, leaving the Pomeroy the only seam in the hills and this is thin and of value for domestic purposes only.

"Andrews classed the higher of the two seams as the Pomeroy, but the lower or Pittsburgh seam he did not correlate with any seam found elsewhere in Ohio. As is well known, he regarded the Pomeroy coal as the Pittsburgh.

"This field furnishes very strong evidence on the position of the Pomeroy coal, for this seam can be followed from hill to hill all the way from Pomeroy to the territory under consideration, and thus the identity of the seam in the two counties is proven.

"In at least five townships in Gallia county where the Pomeroy coal exists, another seam is found from about 25 to 55 feel lower. This seam is in a number of localities much more prominent than the Pomeroy, and is known locally as the Swan creek, Jeffers or Lewis seam. The structure of the coal is shown in the following sections:

Section in Mine of the Swan Creek Coal Company, Near Bladen on the Ohio River.

	Ft.	In.
Sandstone, massive.		
Shales, reported thickness	2	6
Coal, Upper bench	0	4½
Soapstone	1	0
Coal, Lower bench	2	9
Clay, unmeasured.		

"The section shows the coal of the Upper bench thin. It is, in fact, sometimes wanting in this mine. The soapstone below also varies. Rarely is it more than a foot thick and occasionally it disappears.

PLATE XXV—Railroad Tipple, Otto Marmet Co., Raymond City.

"Section in the mine of Samuel Lewis on Swan creek in section 29 of Ohio township:

	Ft.	In.
Coal	1	3
Shales	0	2½
Coal, upper bench	1	6
Coal and shale	2	7
Clay	0	11
Coal, lower bench	3	0

"Here the Upper bench is thicker and more complex in structure.

"These two sections can be duplicated in large number and in several townships. Generally the Upper bench is thin and comparatively unimportant, but occasionally it is of more value than the Lower bench. The structure of the coal is strikingly similar to the Pittsburgh coal on Federal creek in Athens and Morgan counties, already given. In both localities the seam is divided into two benches by a bed of clay or shales. Further the relation of the seam in the two localities is similar with reference to the Ames or Crinoidal limestone. That the coal on Federal creek is the Pittsburgh, there can be no doubt, and the same conclusion is necessarily reached with reference to the Swan creek, Jeffers or Lewis seam of Gallia county.

"It remains now to show the position of the Pomeroy seam in this territory with reference to the lower or Pittsburgh. On or near section 28, Guyan township, in the southwestern corner of Gallia county, the following section was measured with a hand level:

	Ft.	In.
Sandstone	40	0
Coal, Pomeroy or 8a	3	6
Partly covered, sandstone seen	27	0
Coal blossom, Pittsburgh or No. 8		
Shales	15	0

"One more section from Gallia county will be given. This is on section 26 of Clay township, and is taken from Professor Andrew's report:

	Ft.	In.
Sandstone, unmeasured		
Pomeroy coal	1	6
Not exposed	30	0
Sandy shale	10	0
Clay shale	3	0
Top coal	2	0
Ferruiginous black slate	2	0
Coal { Coal	0	10
Coal { Clay	1	6
Coal { Coal	3	6
Clay	2	6

"While Andrews does not name the lower coal, it is clear from his text that he regards it as the Jeffers seam, which as has elsewhere been stated, is the Pittsburgh. In fact, this section was taken at the mine of Abram Jeffers. The 'top coal' of the section is what is elsewhere known as the 'roof coal' of the Pittsburgh seam.

"In Lawrence county the Pittsburgh coal is rarely seen and probably is never more than a black streak. The following section was obtained in the northwest quarter of section 25 of Mason township:

	Ft.	In.
Sandstone	25	0
Shales	11	0
Coal, Pomeroy	4	0
Fire clay	2	0
Limestone	1	0
Shales	19	0
Coal, blossom, Pittsburgh	0	6
Fire clay	1	0

"Not only does this section show both coals, but also the limestone between them, which, as has already been stated, is important in identifying the two seams.

Conclusion.

"To the writer the proof is conclusive, the Pomeroy coal lies above the Pittsburg and is the equivalent of the Redstone seam. Since, however, the name Pomeroy is in general use in Ohio, it will be retained. The Pittsburgh coal being known as No. 8 and the Meigs creek as No. 9, the Pomeroy seam may

appropriately be numbered 8a. For the massive sandstone overlying the Pomeroy coal, the name **Pomeroy** is proposed."

It will be noted from the argument presented by Professor Bownocker that he bases his correlation on the limestone that occurs below this coal, which limestone he takes as a keyrock. In fact, he says that this limestone is even more conspicuous than the Redstone coal itself. This limestone, on which he bases his argument, is seldom present in the core drill holes which we have given, and, in fact, is nearly always absent as are practically nearly all the limestones which are found in the Monongahela series in the northern part of the State.

These limestones seem to have disappeared in the southern part of the State and are replaced with sandstones. Especially is this true in the area under discussion. It would be hard to correlate this coal by using this limestone as the keyrock and from the sections published in this volume, the writer is of the opinion that the Redstone coal is absent and that the coal in Mason county and Putnam county correlates with the Pittsburgh bed of the northern part of the State. The question is of practically no economic importance since only one workable coal appears to be present at this horizon in West Virginia.

CHAPTER VII.

THE CONEMAUGH SERIES.

The beds between the floor of the Pittsburgh coal and the roof of the Upper Freeport coal have been named by Mr. Franklin Platt in 1875, the **Conemaugh series,** from the outcrop along a stream by that name in Cambria county, Pennsylvania. These beds were formerly known as the Lower Barren Measures and later as the Elk river series. The Conemaugh series, as now classified, has a thickness of from 450 to 500 feet near Wheeling, along the Ohio river, and about 600 feet in thickness on the eastern side of the Appalachian coal basin in Monongalia county. Along the western part of Mason county at Gallipolis Ferry, in the section as shown in core drill hole on the Poplar Grove farm (see page 77 of this volume), the Conemaugh series has a thickness of 567 feet. In the Hartford section, near Hartford (see page 65 of this volume), the Conemaugh shows a thickness of 583 feet. In the McClain well No. 1 in Putnam county (P-61), the Conemaugh has a thickness of 540 feet, and of 521 feet in the deep core drill hole, two miles east of Plymouth. This series is not exposed for its full thickness in any portion of the area herein described.

The top of the Conemaugh series comes to the surface along the Ohio river near Hartford and gradually rises above the river until at Gallipolis Ferry, about 140 feet is exposed. In going up the Kanawha river south of Point Pleasant, the series soon disappears and does not re-appear until Red House, where these beds begin to come up gradually until at the southern end of Putnam county, some 400 to 500 feet is exposed.

Dr. I. C. White gives the following description of the Conemaugh in Volume II, page 225, West Virginia Geological Survey:

"The series as thus limited below, consists of two widely

different members, lithologically considered, the upper composed of soft, red and marly shales, the lower of massive, pebbly sandstones. The difference in the rock type is so marked, and especially in the character of the topography made by each, that the First Geological Survey of Pennsylvania and Virginia placed them in two different series, the massive sandstones, at the base of the Conemaugh being classed with the underlying Allegheny. That assignment, based primarily upon difference of rock type, was more philosophical than the present limitations, but the fact that no definite boundary (a sandstone always being subject to sudden and rapid changes in both thickness and character) could be assigned to either the lower limits of the upper one, or the upper limits of the lower one, led Professors Stevenson, Lesley, and other Pennsylvania geologists to extend the limits of the 'Lower Barren Measures' of Rogers down to the horizon of the Upper Freeport coal, a well marked and widely persistent stratum. This arrangement gives definiteness to classification, a great desideratum, but it has the fault of bringing together rocks of very different type, and hence, while apparently preferable to the old and indefinite dividing line between the two series, is yet not altogether satisfactory. Hence it is possible that a future and more detailed study of the series in West Virginia may reveal some more desirable dividing plane between the Conemaugh series and the underlying Allegheny than the present one (U. F. coal), which will retain all of the desirable features of the Rogers classification and at the same time relieve it of indefiniteness.

"Viewed from the standpoint of change in physical conditions, the proper place for such a dividing plane between the Conemaugh and Allegheny beds would be the first general appearance of **red rocks**, near the horizon of the Bakerstown coal about 100 feet under the Ames or Crinoidal limestone horizon. That a great physical change took place soon after the deposition of the Mahoning sandstone rocks, the present basal members of the Conemaugh series, must be conceded, since no red beds whatever are found from the base of the Pottsville up to the top of the Allegheny, and none worth

considering until after the epoch of the Upper Mahoning sandstone.

"The sudden appearance or disappearance of red sediments after their absence from a great thickness of strata is always accompanied by a great change in life forms, and the

"The sudden appearance or disappearance of **red sediments** succeeding the Mahoning sandstone epoch of the Conemaugh may well be considered as the 'beginning of the end' of the true Coal Measures, both from a lithological as well as a biological standpoint, and hence it is possible that the best classification aside from the conveniences of the geologist, would leave the Mahoning sandstone in the Coal Measures, and place the rest of the Conemaugh, as well as the Monongahela series above, in the Permo-Carboniferous. This reference is also confirmed by the character of the fauna and flora, both of which contain many forms that characterize the Permo-Carboniferous beds of Kansas, and the west as may be seen in the lists published on a subsequent page under the detailed description of the principal Conemaugh strata. The lowest 150 feet of these reds is known among oil well drillers, as the 'Big red cave,' since it gives much trouble to them in drilling for gas and oil. The wall of the well through this portion of the columns of rocks must be quickly lined with casing, or it will 'cave' and crumble into the hole from the pressure of the overlying strata, thus often imprisoning the drilling tools and leading to the abandonment of the boring. The nuggets of hard limestone scattered through these red shales constitutes the chief agent in this imprisonment since they readily tumble out from the walls of the hole, and impinging against the drilling tools, principally at the 'jars,' prevent their withdrawal.

"For these reasons, every oil well driller becomes an expert stratigrapher in tracing these **red beds** underground, and they have been so traced in hundreds of borings entirely across the State, when deeply covered by the overlying Monongahela and Dunkard series, so that whether at the surface and visible in broad bands of **red soil** around the hills, or buried under 2,000 feet of higher sediments, the same deep purple and red

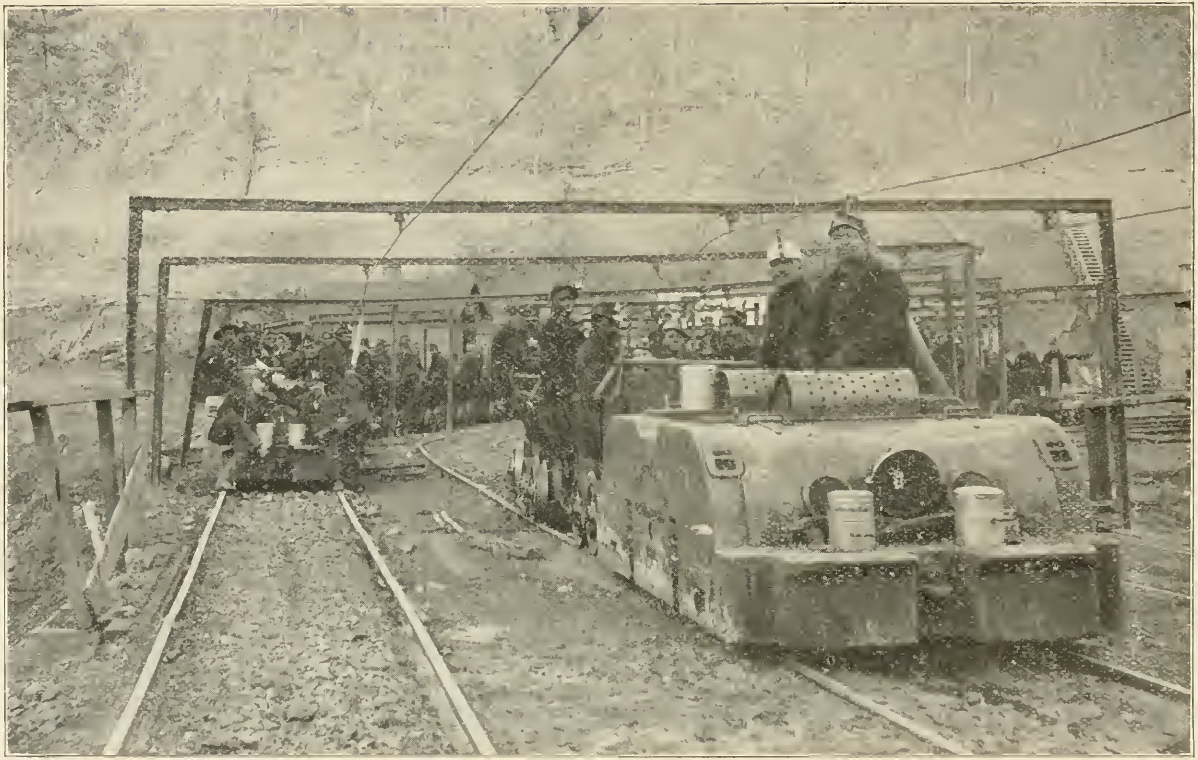


PLATE XXVI—Electric Motors, Otto Marmet Coal and Mining Co., Raymond City.

shales exist in this portion of the geologic column along the belt of country west from the mountain region of the State. Hence, the color is not the result of recent oxidation, but is evidently due to the deposit of **red sediments** derived from the erosion of old land areas of pre-carboniferous time."

DESCRIPTION OF FORMATIONS.

"The Conemaugh series includes the following formations, having a total thickness of from 475 feet in northwest Marshall county to 575 feet in southeast Wetzel county:

Lower Pittsburgh Sandstone.
Pittsburgh Limestones.
Little Pittsburgh Coals.
Connellsville Sandstone.
Little Clarksburg Coal.
Clarksburg Limestone.
Morgantown Sandstone (Murphy Sand).
Elk Lick Coal.
Elk Lick Limestone.
Grafton Sandstone.
Birmingham Shale.
Ames (Crinoidal) Limestone.
Harlem (Crinoidal) Coal.
Pittsburgh Red Shale.
Saltsburg Sandstone (First Cow Run Sand sometimes).
Bakerstown (Barton) Coal.
Pine Creek (Cambridge) Limestone.
Buffalo Sandstone.
Brush Creek Limestone.
Brush Creek Coal.
Upper Mahoning Sandstone (Big Dunkard Sand).
Mahoning Coal.
Lower Mahoning Sandstone.

The Lower Pittsburgh Sandstone.

Below the Pittsburgh coal there is often a heavy sandstone and in some places it attains a thickness of from 20 to 40 feet and becomes massive. This sandstone has been named the Lower Pittsburgh sandstone.

Along the Ohio river the rock immediately under the Pittsburgh coal is slate, as shown in the James MacMillian core drill (see page 172 of this volume), where the bottom is 2 feet 7 inches of slate, while in the James Rayburn core drill hole, one mile north of the MacMillian core drill hole, the stratum immediately underneath the Pittsburgh coal is shaly fire clay. In the section of the B. J. Lerner core drill hole (page 169 of this volume), the stratum immediately under the Pittsburgh coal is fire clay of a thickness of 7 feet and 3 inches, while the Lower Pittsburgh sandstone is replaced with green and red shales.

In Putnam county the stratum immediately under the Pittsburgh coal is often white, soft fire clay ranging in thickness from 3 feet to 7 feet.

The Pittsburgh Limestone.

Underneath the Pittsburgh coal and above the Little Pittsburgh coal there occurs a yellowish limestone, varying in thickness from 1 foot to 18 inches. Dr. I. C. White, in Volume II, page 245, gives the following:

"Two well marked limestone horizons belong in this variable 100 feet of measures at the top of the Conemaugh—one 5 to 6 feet thick and usually found 25 to 35 feet below the Pittsburgh coal, the other 8 to 10 feet thick and 50 to 60 feet below the latter. They are usually known as the Upper and Lower Pittsburgh limestones and are excellent landmarks for determining the horizon of the Pittsburgh coal above. They are often earthy and impure and hence of little economic importance except for farm use."

In the Jackson-Mason-Putnam area these two limestones have almost disappeared and are replaced with red and sandy

shales, but occasionally a yellowish gray limestone from 1 foot to 1½ feet occurs.

The Little Pittsburgh Coal.

At an interval of from 20 to 60 feet below the Pittsburgh coal there often occurs another coal which has been called the Little Pittsburgh bed. In Volume II, page 245, Dr. I. C. White gives the following:

"Two coal beds of little economic value are also often seen in this variable interval at the top of the Conemaugh—one immediately **under** the Upper Pittsburgh limestone 30 to 40 feet from the Pittsburgh coal, and the other immediately **over** the next underlying Pittsburgh limestone. Both coals are seldom present in the same section, and hence it is frequently difficult to distinguish the one from the other on account of the extreme variation in the character of the enclosing rocks, so that both horizons have been designated Little Pittsburgh coal."

The Little Pittsburgh coal attains a thickness of from 3 feet to 3 feet 6 inches in several places south of the Kanawha river. It is being operated for local fuel in Mason county in the neighborhood of Mercer's Bottom. Also it is being operated at Oak Forest in Putnam county by the Oak Forest Coal Company, and was once opened by the Big Hurricane Coal Company, but it has been abandoned.

Sections of the coal are given on subsequent pages, also analysis of sample taken from the opening.

This seam covers a small area in Mason and Putnam counties and appears not to be persistent, but to occur in "pockets." However, very little prospect work has been done except where it occurs above water level, south of Kanawha river.

North of the Kanawha river the seam is nearly always absent and when present it is so thin that it is of no economic or commercial value. The core drill holes already published on the preceding pages, where they penetrate below the Pittsburgh coal, very seldom show much of the Little Pittsburgh bed.

The Connellsville Sandstone.

At from 60 to 90 feet below the Pittsburgh coal there occurs a massive sandstone which has been named the Connellsville sandstone by Dr. John J. Stevenson from Connellsville, Pennsylvania, where this sandstone crops in the bed of the Youghiogheny river. The sandstone is massive and often coarse grained and is one of the finest building stones in the entire series.

This sandstone rises above the river bottom south of Gallipolis station and occurs in massive cliffs throughout the western part of Mason county for a short distance, but when the river turns south, the sandstone disappears again below the river bottoms.

In the southern portion of Putnam county, this sandstone often forms projecting cliffs and on the mountain sides makes a bold terrace.

The Little Clarksburg Coal.

Underneath the Connellsville sandstone there occurs a persistent coal horizon throughout the State which has been named by Dr. I. C. White the Little Clarksburg coal from the city of Clarksburg, where it crops along the valleys of Elk creek and the West Fork river. The coal is often double with 2 or 3 feet of slate or shale separating as many feet of impure, bony coal.

This coal is scarcely ever present in the area described in this volume, but is always represented by a layer of fire clay, which being impervious to water, forms springs on the dip side of the stratum.

On Hurricane creek, near the mouth of Sam's fork, one mile and a half west of the Putnam-Kanawha county line, an opening was once driven into this coal a distance of possibly 100 feet, but the coal was dirty, being interstratified with slate and having a thickness of coal and slate of about 16 inches. The opening is on the land now owned by N. W. Young.

The Clarksburg Limestone.

Just underneath the Little Clarksburg coal there often occurs a limestone which has been named by Dr. I. C. White, the Clarksburg limestone, for the reason that it is finally exposed in the vicinity of Clarksburg along Elk creek at its junction with West Fork river.

This limestone is almost altogether replaced in the area under discussion with sandy shales and when it does occur it has a thickness of from 1 to 2 feet of impure limestone.

The Morgantown Sandstone.

The sandstone that occurs a few feet below the Clarksburg limestone and separated from it by soft shales has been named by Dr. John J. Stevenson, the Morgantown sandstone, from its fine exposures in the vicinity of Morgantown, Monongalia county, where it was once extensively quarried and used in the construction of buildings, among which were the State University buildings.

Dr. I. C. White gives the following description in Volume II, page 250, West Virginia Geological Survey:

"At Morgantown the top of the sandstone lies a little more than 200 feet below the Pittsburgh coal, and the stratum has a thickness of 25 feet. It is usually of a yellowish gray cast, and splits readily into building blocks of any desired size. The rock contains much feldspathic material, and occasionally some lime, and in weathering the rock changes from a bluish gray cast to a dirty brown, and frequently decomposes readily, so that as a building stone for exposed surfaces, it is not a success, some of the stone work at the State University in Morgontown having disintegrated badly within a period of only twenty- five years.

"Several of the locks along the Monongahela river, between Morgantown and Pittsburgh, have been constructed of this stone, and the disintegration of the lock walls is a constant source of expense.

"This sandstone is one of the most persistent members of

the Conemaugh series, and usually forms a line of cliffs or steep bluffs wherever its outcrop extends. Although the stratum is usually only 25 to 30 feet thick, yet occasionally, as on Crooked run in Monongalia county, near the West Virginia-Pennsylvania line, it thickens up to one hundred feet in a solid and massive wall.

"Through Monongalia, Marion, Tyler, Preston, Barbour, Upshur, Lewis, Braxton, Clay, Kanawha, Putnam, Mason, Cabell and Wayne, this stratum can be traced from the Pennsylvania line on the north to the Kentucky boundary on the southwest. It is well exposed along the Ohio river in the region of Huntington, where it makes cliffs 50 to 60 feet high along the hills back from the river valley. It is also conspicuous in cliffs along the Guyandotte, Mud and Coal rivers, as well as along the Great Kanawha, where it has been frequently quarried and used in building the locks below Charleston.

"This stratum produces oil in the 'Shallow sand' districts of Washington, Noble and Monroe counties of Ohio, as well as at some localities in Wirt and Ritchie of West Virginia, where it has occasionally been confused by the oil well drillers with the Dunkard or 'First Cow Run' sand of Ohio. It also produced oil in one well on Dunkard creek, Greene county, Pennsylvania, at about 200 feet below the Pittsburgh coal."

This sandstone comes up out of the Kanawha river near Raymond City and gradually rises to the southeast. At Scary it is in the railroad cut of the Chesapeake and Ohio Railway about 125 feet above the Kanawha river, where it is 22 feet in thickness. It forms cliffs along the Kanawha river from Poca to Scary. The south pier of the old highway bridge across Pocatalico river at Raymond City rests on this sandstone. The top of this sandstone is in the bed of Pocatalico river at the mouth of Rock fork. Throughout the southern part of Putnam county this sandstone forms cliffs and steep bluffs along the mountain sides, but being soft and easily eroded, it does not form any massive cliffs.

PLATE XXVII—Morgantown Sandstone on C. & O. R. R. near Scary.

The Elk Lick Coal.

Just under the Morgantown sandstone or sometimes separated from it by only a few feet of sandy shale, there occurs a coal of very wide distribution which has been named the Elk Lick coal. This coal is of little economic value in the area described for the reason that it is too thin and contains too much foreign matter, such as slate, etc.

The following section was measured on Bills creek, one mile west of Raymond City on land of James H. Stewart, et al.:

	Ft.	In.
Sandstone, Morgantown.		
Dark slate	1	3
Slate with layers of coal	0	4
Coal and slate, fossil plants	0	6
Slate	0	6
Coal and slate	0	6

The above is a typical section of the coal found in this area, where it does not attain a sufficient thickness to be mined.

The Elk Lick Limestone.

From 10 to 45 feet below the Elk Lick coal and from 200 to 225 feet below the Pittsburg coal, there occurs a limestone which has been named by Messrs. Platt in report HHH of the Second Geological Survey of Pennsylvania, the Elk Lick limestone.

This limestone occurs in the bed of the Kanawha river at the Poca Ferry where it is exposed when the movable dam of Lock No. 8 is down during the low water in the summer season. This limestone is impure and rarely more than 2 feet in thickness. It occurs throughout the southern portion of Putnam county.

The Ames (Crinoidal) Limestone.

The most important and interesting stratum, from a geological standpoint, in the entire Appalachian Field is the Ames (Crinoidal) limestone, which was named the "Green Fossiliferous" limestone in the First Geological Survey of

Pennsylvania, and the Crinoidal limestone by Dr. J. J. Stevenson in his work of the Second Survey of Pennsylvania, while Messrs. Andrew and Orton of Ohio have called it the Ames limestone.

The horizon of this limestone is from 250 to 330 feet below the Pittsburgh coal in the area under discussion. In the Poplar Grove section, published on page 77, of this volume this limestone occurs 310 feet below the Pittsburgh coal. In the Big Creek section (page 96 of this volume) the Ames limestone occurs 289 feet below the Pittsburgh coal horizon.

In the Huntington-Kenova section, published by Dr. I. C. White in Vol. II., West Virginia Geological Survey, page 240, the horizon of the Ames limestone is 305 feet below the Pittsburgh coal.

The Ames limestone is only exposed through a small portion of the southern part of Putnam county in the Jackson-Mason-Putnam area and is from 1 to 2 feet in thickness.

Dr. I. C. White has called attention to the fact that all the limestones above the present horizon represent fresh or brackish water deposits, while in the Ames limestone horizon and for a few feet above, Marine fossils abound. This limestone has been long recognized as one of the important guides to the stratigraphy of the coal measures in the Appalachian Field. For list of fossils see Volume II, West Virginia Geological Survey, page 258.

The Harlem (Crinoidal) Coal.

Just below the Ames limestone or often separated from that stratum by a few feet of shale, there occurs a small seam of coal which has been named the Harlem Coal. This coal is generally represented by dark shale, mixed with fire clay in the areas under discussion.

The Pittsburgh Red Shale.

Underneath the Ames limestone and the Harlem coal, there occurs a series of red and brown shales frequently with

lime nuggets scattered through them and often thin layers of sandstone, which from the exposures near Pittsburgh, has been named the Pittsburgh Red shale.

This formation extends across the State of West Virginia and has long been known by the oil drillers as "The Big Red Cave." It causes much trouble and expense to the drillers who are forced to use special care in their work while drilling through this stratum. For a full description, see Volume II, page 228, of the West Virginia Geological Survey.

The Bakerstown (Barton) Coal.

At a distance of from 60 to 100 feet below the Ames limestone and 350 feet to 400 feet below the Pittsburgh coal, there occurs a bed of coal of wide persistency and of some economic value which has been named the Bakerstown coal by Dr. I. C. White from its occurrence near a village of that name in Allegheny county, Pennsylvania.

This coal appears in several places in the southern part of Putnam county, but is thin and impure being composed of alternate layers of slate and coal, measuring from 12 to 20 inches in thickness and is of little economic value.

No lower beds are exposed within this area, and the underlying Allegheny, Pottsville, Mauch Chunk, Mountain Limestone, Big Injun, Berea, etc., are known only from the drill holes, so that their further description is unnecessary.

PART III.

The Mineral Resources of the Jackson-Mason-Putnam Area

CHAPTER VIII.

PETROLEUM AND NATURAL GAS IN JACKSON, MASON AND PUTNAM COUNTIES

Most of the oil and gas yet discovered in West Virginia has been produced from sandstone beds called "Sands" by the drillers. Different names have been given to these sands by the oil fraternity and these terms have gradually come into general usage in describing these beds.

Dr. I. C. White in Volume I (A), page 506, West Virginia Geological Survey, shows the position of the various sands in the geological column, which compilation has been modified to some extent by Mr. Ray V. Hennen in the Calhoun, Wirt and Roane Report which gives the following:

The Oil and Gas Horizons of West Virginia.

Carboniferous	Monongahela Series.	Carroll sand (Uniontown).
	Conemaugh Series.	Minshall (Connellsville). Murphy (Morgantown). Moundsville (Saltsburg). First Cow Run (Little Dunkard), sand (Buffalo). Big Dunkard sand (Mahoning).
	Allegheny Series.	Burning Springs (Upper Freeport) sand. Gas sand (Lower Freeport).
	Pottsville Series.	Gas sand of Marion and Monongalia counties (Homewood), Second Cow Run of Ohio. Gas sand of Cairo. Salt sand of Cairo. Cairo?
	Mauch Chunk Red Shale	Maxton, Dawson, Cairo.
	Greenbrier Limestone,	"Big Lime;" productive only in Putnam and Cabell counties.
	Pocono Sandstones. Catskill Red Beds.	Keener sand and Beckett sand of Milton. Big Injun sand. Squaw sand. Berea Grit.
Devonian.		Gantz sand. Fifty-foot sand. Thirty-foot sand. Stray sand. Gordon sand. Fourth sand. McDonald or Fifth sand. Bayard or Sixth sand.
	Chemung and Portage Beds	Warren First, or Second, Tiona, Speechley sand. No well-defined oil or gas horizons yet discovered in West Virginia.

Before discussing in detail the different oil bearing sands, records of the different wells drilled in the area under consideration in this volume will be given.

Oil Well Records in Jackson County.

Dr. I. C. White in Volume I (A), page 475, gives the following in regard to Jackson county:

"Jackson county lies immediately west from Roane, and borders the Ohio river on the north. The rocks of this area are nearly horizontal, except for a gentle dip from the Ohio river southeastward into the center of a general syncline, the axis of which passes northeast and southwest nearly through the center of the county. Southeast of this axis (which is the main trough of the Appalachian basin) the rocks rise gently to the southeast. This very simple geologic structure is quite unfavorable for the accumulation of either oil or gas into rich pools, and hence when the sands of the Jackson county region have been penetrated by the drill, a little oil, a little gas, and much water have been found in every well, and in nearly every sand, but no oil or gas in commercial quantity, the relief evidently being too slight to permit the separation of the three substances into pools of commercial value. Hence, the future oil history of Jackson dóes not look bright viewed either by the result of several tests or from a purely theoretical standpoint, although it is possible that future wells may find better results in some portions of its large untested area."

A few gas wells have been drilled recently in Washington district near Gay by the Carter Oil Company, and considerable gas has been found in the Salt sand.

The rceords of several of the Jackson county wells have been published in the preceding pages in combination with sections taken near them. The records of those that have not been published and which the writer has been able to get will now be given.

The Kerns Well No. 1.

Record of the G. R. Kerns Well No. 1, located at Kentuck, Washington district, Jackson county, on Laurel fork of Middle fork of Pocatalico river; elevation of surface, 745′ A. T.; well drilled by the Henry Oil Company of Chicago in 1897, and furnished the Survey by G. P. Kerns, Kentuck, West Virginia:

	Thickness. Feet.	Total. Feet.
Unrecorded	1070	1070
Sandstone	210	1280
Lime	155	1435
Big Injun sand ?	72	1507
Lime and shales to bottom	356.	1863

This well starts about 20 feet above the Waynesburg coal and passes through the Pittsburgh coal horizon at about 300 feet.

A small showing of oil and gas was found in the Big Injun Sand.

The Laurel Creek Well.

Record of well (J-8) on Laurel creek of Bear fork of Tug fork of Mill creek, located in Washington district, Jackson county, 3½ miles northeast of Kentuck; elevation of surface, 715′ A. T. (Aneroid); record of well furnished the Survey by Professor John F. Carll:

	Thickness. Feet.	Total. Feet.	
Unrecorded	280	280	Monongahela Series. 345′
Sand (Pittsburgh)	65	345	
Slate	72	417	Conemaugh Series. 565′
Sand (water)	50	467	
Red rock	123	590	
Sand	25	615	
Red rock	148	763	
Red sand	37	800	
White slate	110	910	
Cow Run sand (water)	130	1040	Allegheny Series. 255′
Black slate	70	1110	
Sand	15	1125	
Slate	40	1165	
White sand (show of oil)	60	1225	Pottsville Series. 505′
Black slate	25	1250	
Sand	20	1270	
Black slate	130	1400	
Salt sand	270	1670	

This well starts in the Waynesburg sandstone about 30 to 35 feet above the Waynesburg coal horizon.

The Anderson Well.

Record of the Eliza Anderson well (J-11), located on Billys run of Elk fork of Mill creek, Washington district, Jackson county; drilled by the Carter Oil Company in 1909, and furnished the Survey by Mr. Lee Cady of Spencer, West Virginia; elevation of surface, 765′ A. T. (Aneroid):

	Thickness Feet.	Total. Feet.	
Soil	11	11	Dunkard Series. 110′
Sand	19	30	
Red rock	10	40	
Sand	10	50	
Red rock	10	60	
Sand (3 bailers water at 75′)	50	110	
White slate	20	130	Monongahela Series. 295′
Sand	15	145	
Red rock	20	165	
White slate	25	190	
Red rock	15	205	
White slate	5	210	
Sand	10	220	
White slate	20	240	
Red rock	16	256	
White slate	29	285	
Red rock	10	295	
Pittsburg sand	110	405	
White slate	45	450	Conemaugh Series. 565′
Sand	32	482	
White slate	43	525	
Red rock	15	540	
White slate	10	550	
Red rock	60	610	
Sand	23	633	
Red rock	23	656	
White slate	67	723	
Red rock, "Big Red"	47	770	
White slate	30	800	
First Cow Run sand	28	828	
White slate	6	834	
Red rock	11	845	
White slate	65	910	
Sand	60	970	
Second Cow Run sand (Big Dunkard)	85	1055	Allegheny Series. 255′
White slate	40	1095	
Sand	49	1144	
Black slate	14	1158	
Sand	12	1170	
Black slate	15	1185	
Sand	25	1210	
Black slate	15	1225	

	Thickness. Feet.	Total. Feet.	
Sand (Homewood)	40	1265	Pottsville Series. 567′
Black slate	10	1275	
First Salt sand	40	1315	
Black slate	25	1340	
Second Salt sand	28	1368	
Black slate	127	1495	
Third Salt sand (gas, oil and water)	297	1792	

The Hickle Well.

Record of the G. A. Hickle well (J-17), located in Parchment district, Jackson county, two miles south of Givens; elevation of surface, 698′ A. T.; drilled by the Carter Oil Company in 1910, and record furnished the Survey by Mr. Lee Cady of Spencer, West Virginia:

	Thickness. Feet.	Total. Feet.	
Dirt	8	8	
Clay	2	10	
Gravel	10	20	
White slate	10	30	
Blue slate	30	60	
Red rock	10	70	
Blue slate	10	80	
Sand 4′, White slate 16′, Red rock 10′, Blue slate 30′ — Waynesburg Sandstone	60	140	
Red rock	18	158	Monongahela Series. 265′
Blue slate	7	165	
Red rock	15	180	
White slate	20	200	
Red rock	40	240	
Lime	30	270	
Red rock	15	285	
Lime	10	295	
Red rock	110	405	

	Thickness. Feet.	Total. Feet.	
White slate	59	464	
Red rock	15	479	
White slate	11	490	
Red rock	20	510	
White slate	20	530	
Red rock "Big Red"	75	605	
Sand	15	620	
Red rock	60	680	
White slate	25	705	Conemaugh
Sand	10	715	Series.
Black slate	23	738	555′
Sand	17	755	
White slate	10	765	
Sand	15	780	
White slate	10	790	
First Cow Run sand (Saltsburg)	27	817	
White slate	53	870	
Pink cave	5	875	
White slate	85	960	
Gas sand (Burning Springs), water at 978′	90	1050	
White slate	30	1080	Allegheny
Lime	26	1106	Series.
Sand	19	1125	200′
Coal, Lower Kitanning	5	1130	
Slate	30	1160	
First Salt sand (water) (Homewood)	80	1240	
Sand	40	1280	
Black slate	25	1305	Pottsville
Lime	10	1315	Series.
Second Salt sand	15	1330	475′
Black slate	185	1515	
Salt sand	120	1635	
Black slate	13	1648	
Lime	12	1660	Mauch
Maxton sand	65	1725	Chunk. 97′
Pencil cave	7	1732	
Big Lime	118	1850	
Keener sand	35	1885	
Slate	25	1910	
Big Injun sand (water)	65	1975	
Slate and shells	395	2370	
Brown shales	13	2383	
Berea grit	11	2394	
Total depth		2480	

The Wentz Well.

Record of the Wentz well (J-18) furnished by Lee Cady; located on Right Hand fork of Big run of Little Mill creek, Washington district, Jackson county, N. 80° E., five miles and a half from Ripley; well completed in 1908; elevation of surface, 705' A. T. (Aneroid):

	Thickness Feet.	Total. Feet.	
Yellow clay	10	10	Dunkard Series. 250'
Red rock	45	55	
Lime	5	60	
Sand (Lower Marietta)	10	70	
Red rock	25	95	
Lime	5	100	
Red rock	35	135	
White slate	30	165	
Red rock	40	205	
White slate ....25' } Waynes-			
Sand ....20' } burg	45	250	
Red rock	25	275	Monongahela Series. 285'
Lime	15	290	
White slate	40	330	
Red rock	15	345	
Shales	20	365	
White slate	30	395	
Red rock	15	410	
White slate	30	440	
Sand (Pittsburgh)	95	535	
White slate	32	567	Conemaugh Series. 601'
Red rock	16	583	
Sand	32	615	
White slate	10	625	
Sand	45	670	
Red rock	34	704	
White slate	11	715	
Lime	18	733	
White slate	34	767	
Red rock	29	796	
White slate	74	870	
Lime	6	876	
White slate	14	890	
Red rock	14	904	
White slate	21	925	
Red rock	47	972	
Black slate	38	1010	
Red rock	4	1014	
White slate	71	1085	
Sand	51	1136	

	Thickness. Feet.	Total. Feet.	
Slate	34	1170	Allegheny Series. 288′
Sand	7	1177	
Black slate	16	1193	
White slate	87	1280	
Gas sand	80	1360	
Black slate	64	1424	
Sand, Homewood	68	1492	Pottsville Series. 554′
Black slate	12	1504	
Sand	44	1548	
Black slate	72	1620	
Sand	14	1634	
Black slate	45	1679	
Salt sand	299	1978	
Pencil cave	14	1992	
Big Lime	98	2090	
Big Injun sand	22	2112	
Slate and shells	363	2475	
Brown shale	13	2488	
Berea grit	14	2502	
Slate and shells to bottom	513	3015	

The above well begins in the Dunkard series and extends 513 feet below the Berea sand. No oil or gas was found in any of the sands.

The section also shows the total absence of the coals in the Monongahela and Allegheny series, in this part of Jackson county.

The interval between the bottom of the Pittsburgh sandstone and the Berea sand appears to be 1,953 feet, as compared with 1,866 feet in the Ravenswood well, located north 60° west 12½ miles from this well.

The Barber Well.

Record of the S. L. Barber well (J-47), located on Mill creek, Union district, Jackson county, one mile southeast of Cottageville: elevation of surface, 565 feet. This well is also known as the Henry well and is published in part, in Volume I (A), pages 476-77. Dr. S. L. Barber, on whose land this well is located, watched the drilling very carefully and has kindly furnished the Survey with a detailed record of same. This record differs in some parts from the record published in Volume I (A), and is given below:

	Thickness Feet.	Total. Feet.	
Clay	45	45	Dunkard Series. 77′
Gravel	12	57	
Sandstone (Waynesburg)	20	77	
Coal Waynesburg)	3	80	Monongahela Series. 290′
Fire clay	4	84	
Gray shale	10	94	
Hard limestone	1	95	
Gray shale	4	99	
Red shale	50	149	
Gray shale with streaks of limestone	10	159	
Soft gray sandstone	10	169	
Limestone, hard	10	179	
Blue shale and sandstone	24	203	
Blue slate	10	213	
Red and blue shale	50	263	
Blue slate	70	333	
White sand, Pittsburgh	30	363	
Coal and fire clay (Pittsburgh)	4	367	
Red shale	26	393	Conemaugh Series. 511′
Blue shale	20	413	
Blue slate	115	528	
Blue sandstone	5	533	
Gray shale and slate	50	583	
Blue sandstone	10	593	
Slate	5	598	
Slate with coal, Bakerstown	20	618	
Blue sandstone	35	653	
Red shale	10	663	
Sandstone (Cow Run, very hard)	40	703	
Black slate	10	713	
Gray and black shale	65	778	
Sand	100	878	
Sand	65	943	Allegheny Series. 305′
Blue and gray sand	94	1037	
Black shale	33	1070	
Gray and black slate (mixed with coal)	5	1075	
Blue sandstone	10	1085	
Black slate	13	1098	
Coal, Lower Kittanning	7	1105	
Slate	48	1153	
Sand	13	1166	
Slate	14	1180	
Black shale	2	1182	
Coal	1	1183	
Salt sand	50	1233	Pottsville Series. 362′
Black sand, mixed with lime	96	1329	
Gray sand	50	1379	
Brown shale	6	1385	
Black sand with streaks of lime	48	1433	
Slate	112	1545	

	Thickness. Feet.	Total. Feet.
White lime	100	1645
Sand	5	1650
Big Injun sand	126	1776
Unrecorded	479	2255
Berea sand?	20	2275

This well begins at the top of the Waynesburg sandstone, but being located in the valley of Mill creek, a portion of that sandstone has been eroded. It furnishes important measurements.

The Fisher Well.

Record of the Eliza Fisher well (J-44), located near Goldtown, Ripley district, Jackson county, drilled by the Carter Oil Company in 1910; record furnished the Survey by Mr. Lee Cady of Spencer, West Virginia:

	Thickness Feet.	Total. Feet.	
Loam	5	5	Dunkard Series. 75′
Gravel	25	30	
Sand	10	40	
Blue slate	35	75	
Red rock	15	90	Monongahela Series. 295′
Blue slate	24	114	
Sand	6	120	
Red rock	10	130	
White slate	120	250	
Red rock	46	296	
White slate, hard, (Pittsburgh sandstone)	74	370	

	Thickness. Feet.	Total. Feet.	
Red rock	60	430	
White slate	70	500	
Red rock	5	505	
Lime	20	525	
Sand, Morgantown, water	45	570	
White slate	15	585	
Red rock	15	600	
White slate	5	605	
Sand	5	610	
White slate	50	660	Conemaugh Series. 545′
Lime	10	670	
Slate	15	685	
Sand	25	710	
White slate	5	715	
Lime	20	735	
White slate	10	745	
Sand	25	770	
Black slate	40	810	
1st Cow Run sand, oil at 812′	25	835	
White slate	25	860	
Mahoning sandstone	55	915	
Coal, Upper Freeport	5	920	
Slate	35	955	
Sand	70	1025	
Lime	50	1080	Allegheny Series. 250′
1st Salt sand	50	1080	
Slate	45	1125	
Lime	5	1130	
Black slate	28	1158	
Lime	7	1165	
2nd Salt sand	35	1200	
Black slate	50	1250	Pottsville Series. 520′
Lime	40	1290	
3rd Salt sand	395	1685	
Big Lime	75	1760	
Big Injun sand	100	1860	
Slate	10	1870	
Squaw shells	80	1950	
Slate	267	2217	
Brown shale	15	2232	
Berea Grit	5	2237	
Slate to bottom	199	2436	

This well begins near the bottom of the Dunkard series and extends 199 feet below the Berea sand. The Pittsburgh coal is absent, but the Pittsburgh sandstone is represented by a hard white slate 74 feet thick.

The interval between the bottom of the Pittsburgh sandstone and the Berea sand is 1,862 feet.

The Evans Well.

Record of the Daniel Evans well (J-45), located on Elk fork of Mill creek, Washington district, Jackson county, and drilled by the Carter Oil Company in 1910, the record of which was furnished the Survey by Mr. Lee Cady of Spencer, West Virginia; elevation of surface, 755′ B.:

	Thickness Feet.	Total. Feet.	
Loam	10	10	Dunkard Series. 40′
Sand, Waynesburg	30	40	
White slate	10	50	Monongahela Series. 290′
Sand	40	90	
Red rock	10	100	
White slate	10	110	
Red rock	15	125	
White slate	10	135	
Sand	10	145	
Red rock	15	160	
White slate	15	175	
Red rock	35	210	
White slate	15	225	
Red rock	10	235	
Pittsburgh sand	95	330	
White slate	40	370	Conemaugh Series. 545′
Red rock	5	375	
White slate	10	385	
Sand	40	425	
White slate	25	450	
Lime	10	460	
Red rock	150	610	
Sand	10	620	
Red rock	85	705	
White slate	20	725	
1st Cow Run sand	40	765	
White slate	110	875	
Sand	70	945	Allegheny Series. 225′
Black slate	25	970	
Sand	115	1085	
Black slate	15	1100	
Sand (Second Cow Run) (Homewood)	50	1150	Pottsville Series. 369′
White slate	5	1155	
First Salt sand	50	1205	
Lime	30	1235	
Black slate	29	1264	
Second Salt sand	61	1325	
White slate	124	1449	
Third Salt sand, gas at 1456′	20	1469	

The Hintzman well (J-12) near this one, published in the Gay section, extends through the "Big Injun" and below the horizon of the Berea sand.

The Pittsburgh sandstone in this section appears to retain its massiveness and usual thickness, being hard and difficult to drill.

A core drill hole (J-48) was put down by Messrs. McConnell and McIntosh of Ravenswood, one-half mile south of School House, in Union district, on land of Samuel Webster. The drilling was done by the Uniontown Drilling Company. McConnell gave the Survey the following information in regard to this core drill hole:

The total depth of the hole was 536 feet at which depth was found 6 inches of bone coal directly below 2 feet of black shale. The elevation of this hole is 570 feet A. T. (Aneroid); and the top of the hole commences possibly 30 to 40 feet above the base of the Waynesburg sandstone, since there is 30 feet of Waynesburg sandstone exposed on the side of the hill near where the hole is located; also the Washington coal horizon is about 80 feet above the top of the core drill hole, so the 6 inches of coal found at the bottom would come 616 feet below the Washington coal, which would possibly make it the Elk Lick bed.

The Thomas Well.

Record of well No. 1 (J-46) on the E. F. Thomas farm, located in Washington district, Jackson county, S. 80° E., one mile from Gay, drilled by the Carter Oil Company in 1910; record furnished the Survey by Mr. Lee Cady of Spencer, West Virginia:

	Thickness. Feet.	Total. Feet.	
Clay	12	12	Dunkard Series. 240′
Sand	20	32	
White slate	5	37	
Red rock	13	50	
White slate	30	80	
Red rock	14	94	
Sand	21	115	
White slate	17	132	
Red rock	38	170	
White slate	25	195	
Sand, Waynesburg	20	215	
White slate	25	240	

	Thickness. Feet.	Total. Feet.	
Red rock	15	255	Monongahela Series. 280′
White slate	5	260	
Sand	44	304	
White slate	8	312	
Red rock	18	330	
White slate	32	362	
Sand	8	370	
Red rock	26	396	
White slate	6	402	
Red rock	18	420	
White slate	20	440	
Pittsburgh sandstone	80	520	
White slate	60	580	Conemaugh Series. 580′
Sand	64	644	
White slate	15	659	
Coal (Elk Lick)	3	662	
Red rock	112	774	
Lime	21	795	
White slate	25	820	
Sand	20	840	
Lime	8	848	
Slate	27	875	
Red rock	25	900	
Lime	20	920	
Little Dunkard (1st Cow Run sand)	75	995	
White slate	105	1100	
Big Dunkard, (Burning Springs sand)	105	1205	Allegheny Series. 200′
Slate	30	1235	
Sand	33	1268	
Black slate	32	1300	
Sand (2d, Cow Run) (Homewood), water, 1350′	60	1360	Pottsville Series. 265′
Slate	20	1380	
Sand	55	1435	
Black slate	40	1475	
First Salt sand	20	1495	
Slate	25	1520	
Second Salt sand	15	1535	
Slate	8	1543	
Third Salt sand, to gas at bottom (5,000,000 feet)	22	1565	

The above section shows only one seam of coal at 239 feet under the Pittsburgh sandstone, which may possibly be the Elk Lick bed.

The Woodruff Shaft.

In 1877 a shaft (J-47) was put down on the Woodruff farm, Mill creek, Union district, N. 1° E., one mile from Angerona, for the purpose of testing for silver.

Several years before a well had been drilled for salt water to a depth of 200 to 400 feet, and it was reported that some silver ore was found. In fact, some of the ore reported as occurring in the well (but more probably dropped into it surreptitiously) was sent away for analysis and found by the chemist to be rich in silver; hence a company was organized with Pittsburgh capital and this shaft was sunk. The depth of the shaft was about 500 feet and it started near the top of the Lower Marietta sandstone. It is reported by Mr. Thomas Cunningham of Angerona, that at a depth of 430 feet a thin seam of coal was found from 3 to 4 inches in thickness, which correlates with the Pittsburgh bed. No silver was found in the shaft and it was finally abandoned.

The Shinn Shaft.

Another shaft (J-49) was put down on a farm owned by Albert Shinn on Cow creek, Union district, S. 45° E., one mile and a half from Angerona. This shaft was sunk about the same time as the Woodruff shaft and to a depth of about 350 feet. As no silver was found, this shaft, too, was abandoned.

Records of Oil Wells in Mason County.

Several wells have been drilled in Mason county in search of oil and gas, but up to the present time very little oil or gas has been found. Dr. I. C. White has the following to say in regard to Mason county in Volume I (A), page 479:

"Geological structure and conditions are very similar in Mason to those in Jackson, and hence no productive wells of either gas or oil have yet been found, although some oil and gas occur in every well drilled, along with abundance of salt water, which has long been utilized near Hartford on the

Ohio river in the manufacture of salt, the principal brines coming from the base of the Pottsville (Salt sand) and the top of the Big Injun sand. The conclusion is unavoidable from the results of test wells and the known absence of prominent anticlinals in Mason, that few, if any, good pools of oil or gas can exist within the county."

Records of several of the wells have been given in preceding pages of this volume in connection with sections taken above them and records of the remaining wells that the writer has been able to get will now follow:

The Austin Well.

Record of the Austin well (M-3), located on Salt creek, two miles and a fourth east of Point Pleasant, Clendennin district, on land of John P. Austin; elevation of surface, 620' A. T. (Aneroid); record furnished the Survey by Mr. L. F. Shiflet of Point Pleasant:

	Thickness. Feet.	Total. Feet.	
Pittsburgh coal			
Conductor	20	20	
Shale, fresh water	45	65	
Red rock, cave, very bad cave	105	170	
Blue sand (Morgantown)	30	200	Conemaugh Series. 528'
Red rock, did not cave	50	250	
Shale	150	400	
White sand, water	25	425	
Shale	15	440	
Coal (Brush Creek), water	4	444	
Slate and shale	84	528	
Coal (Upper Freeport)	3	531	
Shale	86	617	Allegheny Series. 197'
Coal (Middle Kittanning)	5	622	
Shale	99	721	
Coal	4	725	
Sand (Homewood), water	28	753	
Slate	22	775	
Coal (Mercer)	4	779	Pottsville Series. 305'
Slate	71	850	
Sand, little gas	35	885	
Slate	145	1030	

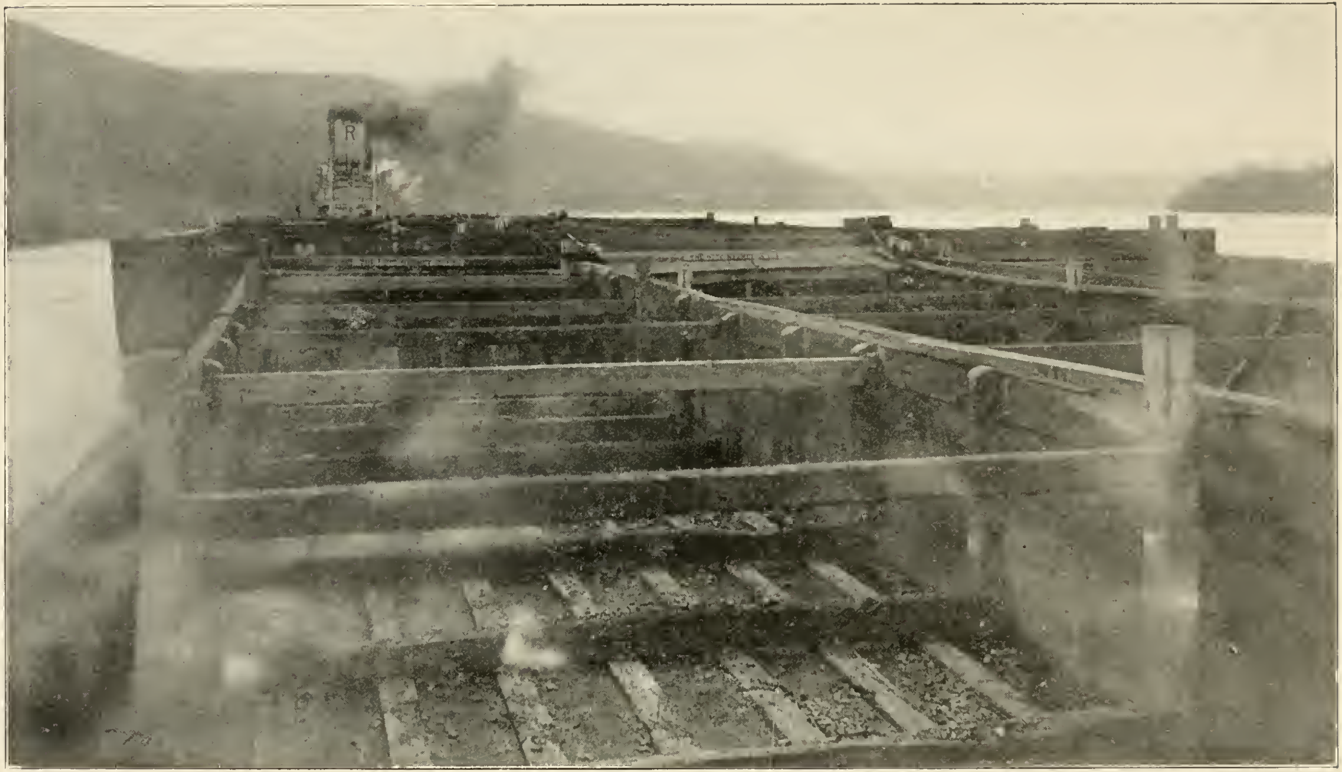


PLATE XXVIII—Steamer Otto Marmet on Ohio River with Empty Coal Barges.

	Thickness. Feet.	Total. Feet.
Big Lime	190	1220
Shale (Big Injun)	100	1320
Sand	3	1323
Shale	30	1353
Sand	8	1361
Slate and shale	89	1450
Sand, full of water ("Squaw")	23	1473
Slate	261	1734
Sand, oil and gas (Berea)	33	1767
Slate and lime	20	1787
Bastard sand, more oil	5	1792
Slate to bottom	53	1845

This well starts at the bottom of the Pittsburgh coal and thus is quite important is revealing the thickness of the several series near the Ohio river.

The interval between the Pittsburgh coal and the Berea sand appears to be 1,734 feet.

The Butler Well.

Record of the Butler well (M-26), located on Guyan creek near the mouth of Knife branch, Hannan district, Mason county, and drilled by the Federal Oil Company in 1904. Elevation of surface 595 feet A. T. (Aneroid). Record furnished the Survey by C. C. Averill, Milton, West Virginia:

	Feet. Thickness	Feet. Total.	
Conductor	20	20	Conemaugh Series. 460′
Unrecorded	410	430	
Sand	30	460	
10″ Casing to 300 feet.			
Slate	80	540	Allegheny Series. 215′
Sand	40	580	
Slate	45	625	
Sand	30	655	
Slate	5	660	
Sand	10	670	
Slate	5	675	
Sand (Homewood)	125	800	Pottsville Series. 805′
Sand, broken	280	1080	
Slate, black	130	1210	
Sand	270	1480	
8″ Casing to 1485′			
Big Lime	60	1540	
Water at 1540′			
Keener Sand	25	1565	

	Thickness. Feet.	Total. Feet.
Little gas at 1545′		
Big Injun	285	1850
6 5-8″ Casing to 1850′		
Slate	210	2060
Berea Sand (Little Gas)	25	2085
Black limestone	20	2105
Slate to bottom	115	2220

The above record begins 20 feet below the Pittsburgh coal horizon and extends to 135 feet below the Berea sand. No oil was found in any of the sands, but little gas was found in the Keener sand and in the Berea.

The interval between the bottom of the Pittsburgh sandstone and the Berea sand appears to be 2,080 feet, as compared with 1,734 feet in the Austin well, located north 10 west, 19 miles from this well, showing a thickening of 346 feet.

The James Swan Well.

Record of the James Swan well (M-30), located on the Ohio river, Robinson district, near the foot of Eight Mile Island, land of James Swan; well put down by Messrs. Spilman, Hensley, Stiles and Kelley, in 1900; the record being furnished the Survey by Mr. James Hensley:

	Thickness Feet.	Total. Feet.
Conductor	58	58
Black and white, and red shales	492	550
Caves	165	715
White sand	10	725
Black sand	85	810
White and black sand	10	820
White sand	50	870
Coal, Lower Kittenning?	6	876
White sand and slate, hard, settles quickly	84	960
Top of Big Salt sand	62	1022
Brown slate	13	1035
White sand, hard	70	1105
Slate	2	1107
White sand	23	1130
Black slate, hard	120	1250
Hard and fine slate	40	1290
Limestone	20	1310
Slate and sand	10	1320
Limestone	25	1345

	Thickness. Feet.	Total. Feet.
Hard shale	5	1350
Gray sand	10	1360
Pure black slate	40	1400
Slate and gray sand	60	1460
Black slate and gray sand	50	1510
Brown shale, showing of oil	15	1525
Black slate	20	1545
Sand	25	1570
Brown shale	21	1591
Berea sand	30	1621

This well starts 75 feet below the bottom of the Pittsburgh coal.

The DeVolt Well.

Record of the DeVolt well (M-32), located on Little Mill creek, Cologne dsitrict, N. 30° W., one mile and a half from Baden, also known as well No. 10, drilled by the Sterling Oil Company; record of same published in Volume I (A), pages 479-80; elevation of surface, 695′ A. T. (Aneroid):

	Thickness Feet.	Total. Feet.	
Drift	20	20	Dunkard Series. 40′
Sand (Waynesburg)	20	40	
Red rock	60	100	Monongahela Series. 300′
White and red mud	85	185	
White sand	5	190	
Red rock	115	305	
White sand	8	313	
Dark slate	17	330	
Trace coal (Pittsburgh)	10	340	
Light sandy shale	25	365	Conemaugh Series. 585′
Light shale	40	405	
Black shale	20	425	
Red rock	191	616	
Gray slate	39	655	
Red rock	35	690	
Hard black sand (1st Cow Run)	12	702	
Flinty slate	20	722	
Gray sand	3	725	
Soft, white sand	15	740	
Blue shale	15	755	
White sand (salt water)	50	805	
Blue shale	10	815	
Brown and blue shale	25	840	
Soft white sand	85	925	

	Thickness. Feet.	Total. Feet.	
Blue shale	20	945	
White sand (gas and salt water)	50	995	
Blue shale	30	1025	
Blue sand	15	1040	Allegheny
Limestone	20	1060	Series.
Gray sand	37	1097	210′
Gray slate	8	1105	
Black and gray slate	30	1135	
White sand (salt water and gas)	35	1170	
Blue shale	45	1215	
Black shale	40	1255	
Gray slate	30	1285	Pottsville
Soft, gray sand	20	1305	Series.
Black and blue shale	145	1450	395′
Sandy shale	5	1455	
Black slate	15	1470	
White sand (salt water and gas)	60	1530	
Big Lime	60	1590	
Hard sand and gray slate 4′			
Limestone 10′			
Gray sand and lime 24′			
Black slate 4′			
Sand 10′	**Big Injun**..263	1853	
Blue sandy shale 21′			
Black slate 4′			
Sand with salt water 12′			
Blue sandy shale 15′			
Gray sand with salt water 159′			
Blue slate	258	2111	
Black slate	13	2124	

This well starts in the Waynesburg sandstone and shows a trace of the Pittsburgh coal at a depth of 300 feet below the bottom of the Waynesburg horizon.

Several more test holes have been put down in Mason county south of the Kanawha river, but each was reported "dry" and thus very little evidence of oil or gas in commercial quantity has been found in Mason county.

Records of Oil Wells in Putnam County.

During the last few years Putnam county has been prospected in several places for oil and gas, several good gas wells being found in the southern portion and a considerable

quantity of gas is now being produced in that part of the county.

Dr. I. C. White in Volume I (A), page 482, West Virginia Geological Survey, has the following to say in regard to Putnam county:

"Putnam county lies directly south from Mason, and it is also bisected by the Great Kanawha river. In its northern half, geological structure and conditions are very similar to those in Mason, and hence no oil or gas in paying quantity has been found, although several test wells have been drilled. The southern portion of the county, however, extends southward to where the dip of the rocks begins to steepen quite rapidly, and hence in the portion of the county south from the Chesapeake & Ohio Railroad there is some chance for oil and gas, so far as geological structure is concerned."

On the following pages records of some of the wells drilled in Putnam county will now be given:

The McCallister Well.

Record of the McCallister well (P-1), located on Turkey creek, one mile south of Byrneside, Curry district, Putnam county; elevation of surface, 665 feet A. T. (Aneroid); record of the well furnished the Survey by Messrs. Holley and Stephenson, Charleston, West Virginia:

	Thickness Feet.	Total. Feet.
Unrecorded	134	134
Sand and slate	12	146
Slate	10	156
Sand	24	180
Slate	15	195
Black sand	125	320
Slate	5	325
Sand	30	355
Pink slate	2	357
Sand with water	43	400
Slate	5	405
Sand	68	473
Slate	5	478
Black lime	52	530
Sand with water	30	560
Slate	10	570
Sand	55	625

	Thickness. Feet.	Total. Feet.
Black lime, with water	65	690
Sand	20	710
Slate	25	735
Shell and lime	50	785
Sand, shell with gas	10	795
Slate	10	805
Salt sand with water	85	890
Slate	65	955
Salt sand	357	1312
Lime	202	1514
Pencil slate	5	1519
Red rock	5	1524
Gas in Big Injun	18	1542
Big Injun sand	30	1572
Lime	250	1822
Slate	148	1970
Sand with oil	10	1980
Slate	20	2000
Berea Grit 30′ / Gas in Berea 3′ / Oil in Berea 3′	36	2036
Total depth of well		2036

The above well is reported to produce 225,000 cubic feet of gas per hour, in the Big Injun sand, and it also had a showing of oil and gas in the Berea sand.

The Woodyard Well No. 1.

Record of Woodyard well No. 1 (P-2), located in Curry district, Putnam county, one-half mile west of Byrneside, on waters of Turkey creek, land of Woodyard; elevation of surface, 730′ A. T. (Aneroid); record furnished the Survey by Messrs. Holley and Stephenson, Charleston, West Virginia:

	Thickness Feet.	Total. Feet.
Unrecorded	135	135
Little Dunkard	15	150
Slate	45	195
Big Dunkard	50	245
Coal (Upper Freeport ?)	3	248
Slate	27	275
Sand	125	400
Slate	5	405
Sand	15	420
Slate	30	450
Sand	30	480
Slate	120	600
Sand	10	610

	Thickness. Feet.	Total. Feet.
Slate	10	620
Sand	30	650
Slate	80	730
Sand	15	745
Slack shale	50	795
Lime	10	805
Sand shell	10	815
Slate	15	830
Salt sand	26	856

The above well is represented to be a gas well in the salt sand.

The McCallister Well No. 1.

Record of the McCallister well No. 1 (P-3), located in Curry district, Putnam county, one-half mile northeast of Byrneside; elevation of surface, 765′; record furnished the Survey by Messrs. Holley and Stephenson of Charleston, West Virginia:

	Thickness Feet.	Total. Feet.
Gravel	10	10
Sand	20	30
Slate and shells	230	260
Sand (gas at 350′)	90	350
Slate	10	360
Sand	60	420
Slate	10	430
Sand	30	460
Slate	40	500
Sand	80	580
Slate	10	590
Sand	60	650
Slate	70	720
Sand	20	740
Slate	30	770
Sand	25	795
Slate	10	805
Limestone	25	830
Sand (gas at 681′ and 881′)	53	883
Slate	5	888
Sand (gas at 895′)	9	897

The above well is reported to produce 3,560,000 cubic feet of gas daily from the Salt sand.

The Albert Maynor Well.

Record of the Albert Maynor well (P-4), located on Turkey creek, one mile and a half south of Byrneside; elevation of surface, 745 feet; record furnished the Survey by Messrs. Holley and Stephenson of Charleston, West Virginia:

	Thickness Feet.	Total. Feet.
Conductor	6	6
Sand and rock shale	25	31
Slate and sand	95	126
Slate	40	166
Sand	104	270
Slate	120	390
Sand	6	396
Slate	100	496
Gray lime	19	515
Sand	10	525
Slate	10	535
Gray lime	55	590
Sand	10	600
Slate	60	660
Sand (gas, 730′)	70	730
Black sand (gas, 735′)	5	735
Slate	20	755
Sand (gas, 755′ and 763′)	8	763
Slate	37	800
Gas sand (gas, 800′ and 810′)	10	810
Slate	20	830
Sand	30	860
Slate	2	862
Sand	6	868
Big pay (gas, 868′ to 873′)	10	878

The volume of gas in the above well is reported to be 3,381,000 cubic feet daily.

The A. M. Alford Well.

Record of the A. M. Alford well (P-5), located in Curry district, Putnam county; one mile and half south of Frank; elevation of surface 700′ A. T.:

	Thickness Feet.	Total. Feet.
Dirt and gravel	25	25
Slate and shells	70	95
Sand	25	120
Slate and shells	60	180
Sand	25	205
Slate	10	215
Coal (Upper Freeport?)	2	217
Sand	25	242
Slate	8	250
Sand	50	300
Slate	15	315
Sand	40	355
Slate	15	370
Sand	15	385
Slate	20	405
Sand	25	430
Slate	40	470
Sand	60	530
Sand	60	590
Slate	70	660
Sand	65	725
Slate	35	760
Limestone	30	790
Gas sand (gas at 803′ and 863′)	73	863
Salt Sand	450	1313
Big Lime	215	1528
Slate	11	1539
Big Injun sand to bottom	9	1548

The above well shows a volume of 1,500,000 cubic feet of gas daily in the Salt sand, and a rock pressure of 300 pounds; it also shows a volume of 703,632 cubic feet of gas daily in the first 3 feet of the Big Injun sand with a rock pressure of 650 pounds.

The McCallister Heirs Well.

Record of the McCallister heirs well (P-6), located in Curry district, Putnam county, three-fourths mile south of Byrneside; elevation of surface, 710′ A. T.:

	Thickness. Feet.	Total. Feet.
Conductor	12	12
Slate	125	137
Sand	44	181
Slate	10	191
Sand	240	431
Slate	110	541
Sand	30	571

	Thickness. Feet.	Total. Feet.
Slate	16	587
Sand	36	623
Slate	68	691
Sand	36	727
Slate	32	759
Sand	8	767
Slate	6	773
Sand	10	783
Slate	25	808
Sand to bottom	18	826

The above well had a rock pressure of 360 pounds the first day after it was drilled. It stood open for fifteen days to test its staying qualities, and at the expiration of that time it was found to produce 1,824,800 cubic feet of gas daily.

The P. A. McCallister Well.

Record of the P. A. McCallister well (P-7), located in Curry district, Putnam county; elevation of surface, 700′ A. T.; record furnished the Survey by Messrs. Holley and Stephenson of Charleston, West Virginia:

	Thickness. Feet.	Total. Feet.
Gravel floor	40	40
Slate	50	90
Sand	20	110
Slate	30	140
Sand	40	180
Slate	15	195
Sand	40	235
Slate	125	360
Sand	30	390
Slate	100	490
Sand	40	530
Slate	10	540
Sand	25	565
Slate	85	650
Limestone	30	680
Slate and shells	50	730
Limestone	35	765
Sand	9	774
Sand (gas at 774′)	31	805
Sand(gas at 805′ to bottom)	12	817

The above well shows a volume of 2,500,000 cubic feet of gas daily.

The William Grass Well.

Record of the William Grass well (P-8), located on Two Mile fork of Turkey creek, S. 80° E., two miles from Frank; elevation of surface, 695 feet; record of well furnished the Survey by Messrs. Holley and Stephenson of Charleston, West Virginia:

	Thickness. Feet.	Total. Feet.
Sand and gravel floor	28	28
Sand	12	40
Slate	15	55
Sand	55	110
Slate	60	170
Sand	20	190
Slate	10	200
Sand	30	230
Slate	20	250
Sand	50	300
Slate	20	320
Sand	80	400
Lime	15	415
Slate	15	430
Sand	40	470
Slate	60	530
Lime	25	555
Sand	45	600
Slate	25	625
Sand and slate	55	680
Slate	20	700
Sand (little gas at 700′)	10	710
Slate	90	800
Sand	10	810
Slate	5	815
Sand to bottom	46	861

The above well showed a volume of 1,110,744 cubic feet of gas daily.

The Frank Harden Well.

Record of the Frank Harden well (P-9), located in Curry district, Putnam county, on Brown creek, N. 80° E., three miles and a half from Ida; elevation of surface, 675 feet; record furnished the Survey by Messrs. Holley and Stephenson of Charleston, West Virginia:

	Thickness. Feet.	Total. Feet.	
Soil and sand	21	21	Conemaugh Series. 245′
Slate and red rock	175	196	
Sand	49	245	
Slate	5	250	Allegheny Series. 255′
Sand	75	325	
Slate	50	375	
Sand	105	480	
Slate	20	500	
Sand	35	535	Pottsville Series. 865′
Slate	65	600	
Sand	40	640	
Slate	15	655	
Sand	20	675	
Slate and shale	160	835	
Sand(gas at 850′; water at 920′)	530	1365	
Black lime	30	1395	
White lime (Big Lime)	200	1595	
Big Injun sand	40	1635	
Slate and shale	432	2067	
Berea sand to bottom	23	2090	

The top of this well starts at 375 feet below the Pittsburgh coal and reaches the Berea sand at a depth of 2,067 feet, making the interval between the Berea and the Pittsburgh coal 2,442 feet.

The Simms Well No. 1.

Record of the Simms well No. 1 (P-14), drilled by the Guyan Oil Company and located S. 85° E., one mile and a half from Scott depot, Scott district, Putnam county; elevation of surface, 610 feet A. T. (Spirit level); record of well furnished the Survey by J. W. Rogers, superintendent of the Guyan Oil Company, Huntington, West Virginia:

	Thickness. Feet.	Total. Feet.
Unrecorded	605	605
Gas sand	175	780
Unrecorded	180	960
Salt sand	345	1305
Unrecorded	25	1330
Little Lime	20	1350
Pencil cave	10	1360
Big Lime	205	1565
Big Injun sand	115	1680
Unrecorded	386	2066
Berea sand (gas, 2070′ to bottom) 248,000 cubic feet.	26	2092

The top of this well starts 215 feet below the Pittsburgh coal, and the top of the Berea sand is reached at 2,066 feet, making an interval between the Pittsburgh coal and the Berea sand of 2,281 feet.

This well is located N. 10° E., four miles and a fourth from the Harden well and shows the strata to thin 171 feet between the Pittsburgh coal and the Berea sand in that distance.

In the Bill creek section, pages 83-85 of this volume, the record of well No. 13, published in connection with said section, shows the interval between the Pittsburgh coal and the top of the Berea sand to be 2,233 feet, thinning 38 feet in a distance of three miles, N. 45° E.

The Davis Well.

Record of the Davis well (P-16), located on Little Guano creek, Buffalo district, Putnam county. Well drilled in 1904; elevation of top, 590′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.	
Conductor	35	35	
Coal and slate (Pittsburgh)	5	40	
Yellow rock, hard shells	35	75	Conemaugh Series. 635′
Sandstone, tough, slate colored	40	115	
Red rock	30	145	
Hard lime	5	150	
Slate	35	185	
Lime	15	200	
Slate	40	240	
Red rock	60	300	
Lime	20	320	
Yellow fire clay	35	355	
Red rock	60	415	
Sand	20	435	
Lime	25	460	
Red rock (pale and gritty)	25	485	
Sand, sharp	25	510	
Slate	30	540	
Sand, water	135	675	
Slate	10	685	Allegheny Series. 250′
Lime, hard	40	725	
Slate	75	800	
Sand, brown	35	835	
Sand, water	35	870	
Slate	10	880	
Coal or black slate (Lower Kittanning)	10	890	
Slate and shells	35	925	

	Thickness. Feet.	Total Feet.	
Sand, water	15	940	
Slate	70	1010	
Sand	60	1070	
Slate	255	1325	Pottsville
Lime	50	1375	Series.
Sand	40	1415	665′
Slate	20	1435	
Sand	155	1590	
Lime	18	1608	
Slate	30	1638	
Sand, water	5	1643	
Sand	25	1668	
Sand, conglomerate, lime and slate	95	1763	
Slate and hard lime, shells, alternately (cased, 1782′)	245	2008	
Slate	75	2083	
Shells	24	2107	
Berea Grit	22	2129	
Slate and sand to bottom	404	2533	

The Cargill Well.

Record of the Cargill well (P-17), located one mile and a fourth southwest of Red House, Scott district, Putnam county; elevation of surface, 597′ A. T.; record furnished the Survey by Mr. Jerome T. Boyers:

	Thickness. Feet.	Total. Feet.
Unrecorded	1127	1127
Top of Salt sand		
Top of Big Lime		1421
Unrecorded	207	1628
White sand (Big Injun)	161	1789
Unrecorded	126	1915
Lime		1915
Unrecorded	200	2115
Slate	2	2117
Sand (Berea?)	154	2271
Sand (Berea)	20	2291
Sand	57	2348
Slate	37	2385
Sand (Gordon ?)	20	2405
Slate	180	2585
Slate and shells to bottom	18	2603

This well starts near the level of the Pittsburgh coal, and hence the interval of the Berea sand below the Pittsburgh coal is 2,271 feet, as given by the driller, but the true Berea is more probably at 2,177 feet.

The Arbaugh Well No. 1.

Record of the Arbaugh well No. 1 (P-10), located in Curry district, Putnam county, drilled by the Holley Oil and Development Company; well completed November 1, 1906; elevation of surface above tide, 690 feet (Aneroid):

	Thickness. Feet.	Total. Feet.
Earth and sand	22	22
Slate and sand	279	301
Sand	29	330
Slate	250	580
Sand	70	650
Slate	30	680
Sand	35	715
Slate	85	800
Sand	15	815
Slate and shells	20	835
Sand	493	1328
Lime	212	1540
Big Injun sand	35	1575
Slate	20	1595
Slate	45	1640
Lime and sandy shells	205	1845
Slate	181	2026
Sand, Berea Grit (gas)	15	2041

This well showed a volume of 599,436 cubic feet of gas daily in the first 8 feet of the Berea sand.

The J. E. McCallister Well No. 1.

Record of the J. E. McCallister well No. 1 (P-11), located in Curry district, Putnam county; well completed May 25, 1906; record of well furnished the Survey by Holley and Stephenson of Charleston, West Virginia; elevation of surface, 770′ A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.
Sand	26	26
Slate and shells	127	153
Sand (little gas at 153′)	129	282
Slate (little gas at 280′)	26	308
Sand (little gas at 470′)	168	476
Slate (little gas in slate at 585′)	154	630
Sand (gas at 865′)	30	660
Slate	90	750

	Thickness. Feet.	Total. Feet.
Sand	45	795
Slate	70	865
Sand to bottom (strong pay at 897')	62	927

The above well produced a volume of 1,361,865 cubic feet of gas in 24 hours.

The East End Land Company's Well No. 2.

Record of well No. 2 (P-58), located on the East End Land Company's farm in Teays Valley district, Putnam county; well completed December 17, 1909; record of well furnished the Survey by United Fuel Gas Company of Charleston, West Virginia:

	Thickness. Feet.	Total. Feet.
Conemaugh Series	450	450
Allegheny Series (water at 630')	185	635
Roaring Creek sandstone	42	677
Slate, black	3	680
Sand	10	690
Slate, white	20	710
Slate, black	50	760
Sand	40	800
Slate, black	25	825
Slate, white	35	860
Slate, black	68	928
Little Salt sand (show of oil)	27	955
Slate, black	30	985
Lime, sandy	15	1000
Slate, black	55	1055
Slate, white, sandy	10	1065
Slate, black	32	1097
Shells, hard, sandy	3	1100
Shells, sandy	14	1114
Sand, gas, soft and white	2	1116
Slate, black	1	1117
Top of Big Salt sand		1117

The Higginbotham Well.

Record of the Higginbotham well (P-19), located on Bee Gum branch of Buffalo creek, two miles and a half N. 20° E. from Red House, Buffalo district; elevation of surface, 700' A. T. (Aneroid):

	Thickness. Feet.	Total. Feet.
Unrecorded	1380	1380
Salt sand	230	1610
Black slate	10	1620
White Lime (Big Lime)	173	1793
Black slate	27	1820
Sand ....50′ } Big Injun sand		
Black slate .... 5′ } (show of oil at		
Sand ....20′ } 1875′)	75	1895

This well starts about 200 feet above the Pittsburgh coal, which would make the Big Injun sand about 1,620 feet below the Pittsburgh coal.

The Harbour Well No. 1.

Record of the Harbour well No. 1 (P-54), located in Teays Valley district, one-fourth mile northeast of Hurricane; elevation of surface, 680′; record furnished the Survey by Judge T. H. Harvey, President of the Hurricane Oil and Development Company:

	Thickness. Feet.	Total. Feet.	
Gravel and quicksand	8	8	
Slate and red rock	47	55	
Sand	10	65	
Cave, rock and slate	225	290	
Cow Run sand	35	325	
Slate	220	545	
Sand (Second Cow Run), water at	160	705	
Coal	3	708	
Slate	17	725	
Sand (gas and water)	300	1025	Pottsville Series. 740′
Slate	20	1045	
Gas sand (water)	200	1245	
Slate	15	1260	
Salt sand (water)	205	1465	
Big Lime	113	1578	
Keener sand	25	1603	
Lime	97	1700	
Big Injun sand (cased 1828′)	100	1800	
Lime formation and slate	398	2198	
Berea sand	22?.	2220	

This well starts 80 feet below the Pittsburgh coal and reaches the Berea sand at 2,198′, giving it an interval of 2,278 feet below the Pittsburgh coal.

The H. O. Sowards Well.

Record of well No. 1 on the H. O. Sowards farm, (P-55), located in Teays Valley district, Putnam county, on Sleepy creek, N. 45° W., two miles from Hurricane; record furnished the Survey by the United Fuel Gas Company of Charleston, West Virginia:

	Thickness. Feet.	Total. Feet.
Sand, red rock, and slate	495	495
Sand	65	560
White slate	60	620
Water sand	60	680
White slate	15	695
Sand	40	735
Slate	5	740
Sand	11	751
Coal	5	756
White slate	34	790
Sand	35	825
Lime	5	830
Black slate	35	865
Coal	4	869
Slate	96	965
Sand	24	989
Coal	2	991
Sand	4	995
Slate	130	1125
Slate and sand shells	10	1135
Cap	3	1138
Sand, dry (gas)	26	1164

The East End Land Company Well.

Record of well on the East End Land Company's farm (P-57), located in Teays Valley district, Putnam county; elevation of surface, 780′ A. T. (Aneroid); record furnished the Survey by the United Fuel Gas Company of Charleston, West Virginia:

	Thickness. Total.	Total. Total.
Conductor	16	16
White slate	60	76
Red rock	90	166
White slate	115	281
Lime	10	291
White slate and shells	110	401
Red rock	90	491

	Thickness. Feet.	Total. Feet.
White slate and shells	20	511
White sand	50	561
White slate	40	601
Lime	10	611
Sand	20	631
White slate	15	646
Sand	5	651
First Cow Run sand	125	776
Coal and slate	10	786
Sand	29	815
White slate	45	860
Second Cow Run sand	30	890
Coal and black slate	76	966
Sand and lime	18	984
Black slate and coal	22	1006
White slate	10	1016
Black slate	70	1086
White slate and lime	10	1096
Gray sand	9	1105
Gas sand (gas at 1123′)	30	1135

The several coal companies operating on the Pittsburgh coal bed along the Kanawha and Pocatalico rivers early in 1911 concluded to put down a test well to see if any coals of commercial value could be found in the Allegheny and Kanawha series at a reasonable depth beneath the surface. This core drill hole, which was finished on the 13th of August, 1911, while not developing any coal of present commercial value, is of great economic and scientific importance, since it gives accurate knowledge of the several beds at a locality where the different coal horizons are deeply buried. The Survey is under obligations to the mining companies in question and also to Hon. James H. Nash of Charleston, West Virginia, through whose courtesy this valuable record is here published:

The Plymouth Core Drill Hole.

Put down by the Otto Marmet Coal and Mining Company, Black Betsey Coal and Mining Company, and the Plymouth Coal and Mining Company, on the Right Hand fork of Pocatalico river, Pocatalico district, Putnam county, two miles and one-half east of Plymouth:

	Thickness. Ft.	In.	Total. Ft.	In.	
Pittsburgh coal					
Sandy shale and concealed to top of core drill hole	20		20		
Surface	25	1	45	1	
Sandstone	4	2	49	3	
Soft sandy shale	2	9	52		
Hard, sandy shale	4	5	56	5	
Soft sandy shale	7	6	63	11	
Hard slate	4	4	68	3	
Soft red shale	19	6	87	9	
Sandy shale	12		99	9	
Green sandy shale	4	10	104	7	
Sandy shale ..10′ 2″ Sandstone, coarse grained, dark 9′ 3″ Sandstone, fine grained .... 4′ 8″ — Connellsville sandstone	24	1	128	8	
Red shale	7	5	136	1	
Green, sandy shale, fine grained.	12	5	148	6	
Red shale	0	5	148	11	
Red and green shale	2	9	151	8	
Green shale	2	0	153	8	
Sandy shale	4	4	158	0	
Red shale	7	3	165	3	
Green shale	0	11	166	2	
Red shale	6	3	172	5	
Green shale..................	1	2	173	7	
Red shale.....................	0	11	174	6	Conemaugh
Green shale...................	7	0	181	6	Series
Red and green shale...........	3	8	185	2	521′5″
Red shale.....................	10	6	195	8	
Sandstone, gray fine grained, 4′10″ Sandstone, medium grained ....21′ 3″ Sandy shale .. 7′ 1″ — Morgantown sandstone	33	2	228	10	
Red shale	0	10	229	8	
Green shale	1	5	231	1	
Red shale	0	7	231	8	
Green, limy shale (Elk Lick? Limestone)	5	0	236	8	
Red shale	9	5	246	1	
Limy shale	0	4	246	5	
Green shale	12	1	258	6	
Black slate	0	10	259	4	
Sandy shale	2	0	261	4	
Sandstone, fine grained, gray 24′2″ Sandstone, very fine grained, dark 8′2″ Sandstone, coarse grained, conglomerate ..15′10″ — Grafton sandstone	48	2	309	6	
Green limy shale (Upper Ames?)	16	0	325	6	
Sandstone	3	4	328	10	
Limestone, fossiliferous (Lower					

	Thickness. Ft.	In.	Total. Ft.	In.	
Ames?)	2	7	331	5	Conemaugh Series. 521′5″
Sandy shale	0	11	332	4	
Red shale	2	11	335	3	
Hard, green limy shale	2	3	337	6	
Soft slate	1	6	339	0	
Hard slate or fire clay	4	4	343	4	
Soft shale	3	0	346	4	
Hard sandy shale, fine grained	12	6	358	10	
Soft shale	2	8	361	6	
Red shale	2	3	363	9	
Green, limy shale	4	9	368	6	
Yellowish sandy shale	3	1	371	7	
Red shale	4	6	376	1	
Light sandy shale	7	8	383	9	
Sandstone, medium coarse grained, conglomeratic (Buffalo)	65	5	449	2	
Slate (Brush Creek coal horizon)	1	10	451	0	
Mahoning sandstone: Sandstone, fine grained, micaceous .....17′6″; Sandstone, conglomerate ... 0′8″; Sandstone, hard, coarse grained ..... 5′0″; Sandstone, medium fine grained, micaceous .... 6′8″; Sandstone, coarse grained ....40′4″	70	2	521	2	
Slate	0	3	521	5	
Coal, hard, blocky, Upper Freeport	0	3	521	8	Allegheny Series. 195′9″
Slate	0	2	521	10	
Fire clay	4	1	525	11	
Light sandy shale	5	4	531	3	
Upper Freeport sandstone: Light gray sandstone, very micaceous .30′ 1″; Fine sandy shale ......19′11″; Sandstone, fine grained .... 2′ 0″; Sandy shale .. 3′11″; Sandstone, medium coarse 4′ 4″	60	3	591	6	
Sandy slate	6	1	597	7	
Lower Freeport: Coal, hard blocky ..... 0′ 1″; Slate .... 0′ 6″; Coal and slate. 0′ 2″	0	9	598	4	

		Thickness. Ft.	In.	Total. Ft.	In.	
Sandy shale.... 5′ 9″						
Dark, sandy shale ....12′ 1″						
Sandstone, fine grained.. 2′10″		27	9	626	1	
Sandy shale, dark......... 2′ 8″						
Sandstone...... 4′ 5″						
Slate		1	0	627	1	
Coal and slate.. 0′ 4″	Upper Kittanning?..					
Coal............ 0′ 2″		0	6	627	7	
Fire clay........................		2	6	630	1	
Sandy shale.... 5′ 5″						
Sandstone, fine grained, dark 24′11″		41	7	671	8	
Sandstone, gray very fine grained ....11′3″						
Fire clay and slate (Middle Kittanning?)		1	2	672	10	Allegheny Series. 195' 9"
Sandstone, gray, medium coarse ....25′ 2″						
Sandy slate (mostly sandstone) ....4′ 0″		32	11	705	9	
Sandstone, dark, micaceous .... 3′ 9″						
Slate		1	2	706	11	
Sandstone		0	2	707	1	
Coal............ 0′ 2″	Lower Kittanning? No. 5 Block? Coal......					
Sandstone, coarse grained 0′10″						
Sandy slate, dark......... 0′9½″		2	3	709	4	
Coal, hard, blocky....... 0′5½″						
Black slate, soft..		7	10	717	2	

		Thickness. Ft.	In.	Total. Ft.	In.	
Sandstone, medium coarse grained, dark micaceous ...51' 1" Sandy shale dark......... 1' 1" Sandstone, conglomerate 8' 5"	Homewood sandstone	60	7	777	9	
Coal, hard splint 0' 2" Gray slate, fossiliferous... 6' ½" Coal and slate, laminated..... 1' 1"	Lewiston coal......	7	3½	785	½	
Slate, dark fossiliferous.........		1	8½	786	9	
Sandstone, fine grained..........		0	10	787	7	
Slate, gray......................		5	2½	792	9½	
Coal, splint.... 0'2½" Slate, dark 0' 4" Coal, splint.... 0'2¼" Coal and bone.. 0' 6" Coal, hard blocky........ 1'4½"	Coalburg?	2	7¼	795	4¾	Kanawha Series. 130'11"
Soft slate......................		0	2½	795	7¼	
Fire clay........................		2	1¼	797	8½	
Slate, Dark......................		25	11½	823	8	
Coal, hard block, glossy.. 0'11" Slate and coal, laminated.... 0'11"	Winifrede?	1	10	825	6	
Fire clay........................		1	2	826	8	
Sandy shale, fine grained........		10	4	837	0	
Coal, hard, block........ 1' 3" Slate, dark, fossiliferous.. 1'6½" Coal and slate.. 0'1½"	Cedar Grove?....	2	11	839	11	
Shale, fossiliferous..		0	8	840	7	
Fire clay, soft, to bottom of hole...		3	6	844	1	

This record shows the absence of coal beds of commercial value in the Conemaugh, Allegheny and upper half of the Kanawha series. The identifications given for the several coal horizons in the Allegheny and Kanawha series may not be exact, but the top members of each are most probably correctly placed. Oil and gas well borings put down near this core drill hole give a total thickness of 737 feet for the Pottsville series in this region, and thus about 600 feet of that series remains unpenetrated by the core drill hole, about half of which would belong in the Kanawha series, and the other or

lower half in the New River group. Hence the boring did not reach to the level of the Campbell's creek or No. 2 Gas seam, the most persistent member of the Kanawha series of coals, the horizon of which would come 100 to 150 feet lower in the measures.

The "Charleston Sandstone" horizon of the United States Geological Survey, which extends from 383′ 9″ to 777′ 9″ has a thickness of 389 feet, and includes, as it does at Charleston, portions of three geologic series; viz., the base of the Conemaugh, all of the Allegheny, and the top member (Homewood) of the Pottsville series, and hence should not be retained in geologic nomenclature, even for the vicinity of Charleston.

The "fossils" in the Lower Ames limestone at 329 feet are not marine but of fresh or brackish water types, while the "fossiliferous" slate and shale in the Kanawha series contains plant remains.

DESCRIPTION OF THE OIL AND GAS SANDS.

The Murphy Sand.

From 175 to 225 feet below the Pittsburgh coal there often occurs an oil bearing sand that corresponds to the Morgantown sandstone, having received the latter name from the city of Morgantown, Monongalia county, West Virginia, where it crops out about half-way up the hillsides. It is known to the oil fraternity as the Murphy sand.

In Mason county along the Ohio river, several shallow wells have been put down and a show of oil has been found in this sand at a depth of about 220 feet below the Pittsburgh coal.

First Cow Run Sand.

At a depth of 300 feet to 375 feet below the Pittsburgh coal, there occurs an oil producing stratum which has been named by oil well drillers, the First Cow run sand from a stream by that name in Washington county, Ohio, where it occurs 300 to 315 feet below the Pittsburgh coal. Allowing

for the thickening of the measures to the southeast, this formation would correspond to either the Saltzburg sandstone or the Buffalo sandstone of the Conemaugh series. It is probable that this is the sand that produces the oil in the neighborhood of Sandyville, Jackson county.

The Dunkard Sand.

Occurring at an interval of from 300 to 600 feet below the Pittsburgh coal and of a thickness ranging from 40 to 100 feet, there occurs a sand which the drillers have called the Dunkard sand. It received its name from Dunkard creek, Greene county, Pennsylvania, near the mouth of which some wells produced oil from this sand as early as 1863, and where it corresponds to the Buffalo and Mahoning sandstones.

In the western part of Greene county, Pennsylvania, a small break occurs in this sand and the upper division is called the Little Dunkard and the lower division is called the Big Dunkard; hence the true horizon of the Dunkard sand is from the top of the Buffalo sandstone to the base of the Conemaugh series, and therefore the term Dunkard sand is frequently applied to the First Cow run sand.

The Gas Sand.

The term "Gas sand" is often applied to a gas bearing stratum in some of the counties of West Virginia, coming from 600 to 650 feet below the Pittsburgh coal. This sand corresponds to the horizon of the Lower Freeport sandstone of the Allegheny series.

The Second Cow Run Sand.

According to Professor J. A. Bownocker, the top of the Second Cow run sand comes 451 feet below the top of the First Cow run sand, and hence is 765 feet below the top of the Pittsburgh coal. This sand seems to correlate with the Homewood sandstone at the top of the Pottsville series. It may possibly correspond to the Clarion sand at the base of the

Allegheny series, but the evidence is mostly in favor of the former identification, as recently determined by Ray V. Hennen of the West Virginia Geological Survey.

The Salt Sand.

The Salt sand of the drillers in West Virginia constitutes the main portion of the Pottsville series of rocks and quite frequently consists of three to four distinct sandstones, separated by shales containing thin coal beds.

This sand has been so named by the oil fraternity on account of the salt water which is often encountered in drilling through it. It is an important oil and gas horizon in several regions of West Virginia. The "Yellow creek" and "Steer creek" fields of Calhoun county, the "Flat fork" field of Roane county, the "Volcano" field of Wood and Ritchie counties, the "Burning Spring" field of Wirt county, the "Hurricane" field of Cabell and Putnam counties, the "Browns creek" field of Kanawha and Putnam counties, and the "Turkey creek" field of Putnam county,—all produce considerable oil and gas in paying quantities from this Pottsville series. One of the upper members of this group is often called the "Gas sand."

In the Jackson-Mason-Putnam area, the Salt sand series ranges in thickness from 300 to 800 feet and occurs 800 to 850 feet below the Pittsburgh coal.

The Maxton Sand.

Occurring just above the "Pencil cave" in the Jackson-Mason-Putnam area, there is a sandy horizon ranging in thickness from 10 to 140 feet, which has been designated by oil well drillers as the Maxton sand. This sand does not produce any oil or gas wells in paying quantities in the area under discussion.

The Big Injun Sand.

The easiest stratum to identify by the oil well drillers in the Jackson-Mason-Putnam area is the Big Injun sand. It

comes directly under the Big Lime ("Greenbrier Limestone") and varies in thickness from 75 to 300 feet. In some portions of the district it is often separated by slate or even red shale.

Dr. I. C. White in Volume I (A), page 79, West Virginia Geological Survey, gives the following description of the Big Injun oil sand:

"The Big Injun oil sand of the drillers is a hard and often fine grained gray sandstone, with usually two, and occasionally three or four, open, coarse and porous, sometimes pebbly layers, filled with oil, gas, or salt water, called 'pay' streaks by the drillers; in Monongalia, Marion, and eastern Wetzel counties it is often unbroken by slate from top to bottom, and usually 140 to 150 feet thick, with a gas 'pay' at 15 to 20 feet in the rock; the first oil 'pay' at 60 to 75 feet; the second or main one at 80 to 90 feet; and often a third at 100 to 110 feet below the top of the sand. In Tyler, Pleasants, Ritchie, and other counties, the uppermost 20 to 30 feet of the 'Big Injun' of Monongalia, Marion and Wetzel, usually separated from the main body of the rock by from 5 to 15 feet of dark slate, is then called the 'Keener sand,' and becomes an important oil and gas zone in the counties mentioned, though in Monongalia, Marion and eastern Wetzel nothing but gas has ever been found at this horizon, the main body of the 'Big Injun' oil of these counties occurring at 75 to 90 feet below the top of the sand."

This sand has not yet been productive of either oil or gas in the area discussed in this volume.

The Berea Grit Sand.

The next sand below the "Big Injun" that is easily recognized by drillers is the Berea Grit, coming from 1,600 to 2,800 feet below the Pittsburgh coal. It ranges in thickness from 20 to 30 feet and produces both oil and gas in Brooke, Hancock, Pleasants, Wood, Wirt, Ritchie, Calhoun, Cabell and Lincoln counties, but no productive oil wells in this sand have yet been found in the Jackson-Mason-Putnam area. This sand is correlated with the "30-foot" sand of Greene county, Pennsylvania, by Messrs. R. W. Stone and F. G. Clapp, in

Bulletin 304, United States Geological Survey. They give the following description:

"In this county the 30-foot sand is not the same as the 30-foot in Butler and Armstrong counties, but probably corresponds with what is sometimes known as the Gas, Butler or Murrysville sand. It agrees closely with the Berea sand of Beaver county, Pennsylvania, Jefferson county, Ohio, and Brooke county, West Virginia. It is sometimes difficult to decide whether a sand noted as 30-foot in well records is in reality the 30-foot, Gantz or some local sand, but this question can generally be answered by noting the positions of the red beds encountered by the drill. Between the 30-foot and Gantz sands lies a thin bed of red shale which is found in the wells of Washington county and generally in western Greene county, and which has been provisionally correlated with the Bedford shale of Ohio. The next lower red occurs 100 to 200 feet deeper, at the horizon of the Nineveh sand."

None of the lower sands below the Berea has yet been found in the area under discussion.

Jackson-Mason-Putnam County Well Records.

The following tables contain the abbreviated records of the different wells and core drill test holes in the Jackson-Mason-Putnam county area, also the levels of the surface of these wells above tide. While prospecting for oil and gas has been going on for years in this area, yet the search has not been very fruitful and the work in prospecting has been done by many different companies and individuals, some of whom have long since removed from the State and other of the individuals are dead; so it has been a hard task to get accurate records of the different wells. Through the courtesy of the various companies and individuals the writer has been able to gather and collect records of about one hundred wells and has taken the levels and locations of about forty wells more. It is true that in some the records are very meagre, as some drillers are careless in keeping accurate logs of the wells when they are drilling same.

The importance of keeping accurate and detailed records

of all strata passed through from a scientific standpoint cannot be over estimated. It is especially important that the drillers should note the position, thickness and character of all sands, coals, red beds, limestone and dark slates as well as the horizon at which oil, gas or water is encountered.

Dr. I. C. White in Volume I (A), Preface, West Virginia Geological Survey, gives the following in regard to the importance and value of such records.

"The geologic data given to the citizens of our domain practically free of expense, has cost the operators millions of dollars in their fruitful search with the drill. That they will spend many millions more in piercing the rocky envelope of the State for these treasures of light and fuel, goes without saying. The writer has endeavored to enlist the aid of the Carnegie Institution of Washington, D. C., in an effort to secure more carefully kept records rendered available to geology through this enormous expenditure of money in drilling for oil and gas in West Virginia, but as yet the officers of that institution have failed to embrace this opportunity to add so immensely to the sum of human knowledge at only a small outlay in money. The great oil producing companies would most heartily co-operate in any such endeavor by giving facilities for securing samples of the drillings, making more numerous and accurate (steel line) measurements, etc., but they cannot be expected to do such purely scientific work at their own expense, and entirely on their own initiative. If the Survey could secure the funds to employ two men at the modest salaries, ($60 to $75 per month), one to attend the drill by day, and the other by night, recording measurements and securing samples from every sand pumping, the results thus obtained would prove of the greatest value, especially in the distant future of the State, when the search for oil and gas shall have long been ended with their exhaustion, and a knowledge of the State's deeply buried coal resources shall prove of great value to her citizens. It is hoped that some means of securing and preserving such valuable data now rendered possible in so many counties, may soon be obtained before the enormous expenditures required in drilling operations shall have ended forever."

Wells in Jackson County.

The following is a summarized table of wells and core drill test holes in Jackson:

SUMMARIZED RECORD OF WELLS IN JACKSON COUNTY

No. on Map	Name of Well	Location — District	OWNER	Elevation	Pittsburgh Coal			Cow Run		Salt Sand		Big Lime		Big Injun		Berea		Total Depth	Producing Sand
					Depth (top)	Elevation (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness		
1.		Washington	Carter Oil Co.	638															
2.	Boggess No. 1	"	" " "	660	240	420		765	30			1615	31	1695	75	2214	25	2340	
3.	McClain No. 1	"	U. S. Coal & Oil Co.	780A.T.	388?	292				1456	340	1825	175	2000	150	2150	35	2475	(Dry hole)
4.	C. R. Kerns	"	Henry Assoc.	745B.T.	260?	485?						1070?		1435	172			1863	
5.	Smith	"	C. E. G. Co.																(Show of oil, 1435')
6.	"	"	Frank Marlin	748															
7.	John Riley	"	John Riley et al.	712	313	399				1445								1493	(Show of oil, 1483')
8.	" "	"	Augusta	715	345			910	130	1400	270							1600	(" " " 1430')
9.	Staats No. 5	"	Staats et al.	712															
10.	" No. 6	"	" " "	658				850		1500								1600	
11.	Mrs. Anderson	"	Carter Oil Co.	765	325?	440?		970	85	1275		1792		1900				2492	Salt sand (gas well)
12.	Heintzman	"	" " "	716				860	20	1250		1725	145	1870	25	2301	10	2325	Berea (gas at 2303')
13.	Staats et al No. 2	"	Staats et al.	685														1600	(Small show of oil)
14.	" " " No. 1	"	" " "	635				860	110	1413?	42							1557	(" " " ")
15.	" " " No. 3	"	" " "	650				880	110									950	(" " " ")
16.	" " " No. 4	"	" " "	640				850										2200	
17.	G. A. Hickel	"	Carter Oil Co.	698	464														
18.	Wentz No. 1	"		705	535	170				1679	299	1992		2090		2488	14	3015	
19.	Adams No. 1	Ravenswood	Moore & Bros	600														1200	
20.	Hawks No. 1	"	" " "	780	650	130												1010	
21.	Ayers No. 3	"	" " "	625	495	130		820	20									860	
22.	" No. 2	"	" " "	610	480	130		805	20									860	(Oil)
23.	" No. 1	"	" " "	600	470	130		800	20									860	(Oil)
24.	Moore No. 1	"	" " "	600				800										860	
25.	" No. 2	"	" " "	605				810										870	
26.	" No. 3	"	" " "	605				810										870	
27.	Murray No. 1	"	Hope Gas Co.	600	550	50		835	15	1500	120			1650	137			1787	
28.	Tidd No. 1	"		650														1898	Berea (gas well)
29.	Roloff No. 1			630														600	
30.	J. M. White No. 1	Ravenswood		577	440	137		715	15	1351	31	1610	105	1770	50	2120	5	2140	
31.	Cox			585	341	244	5?							1710	22	2203	30	2232	
32.	Dernberger	Grant		600														600	
33.	Roberts	"	Hudson et al.	725				711	14									725	
34.	Robinson	"	Murrayville O. & G. Co.	600														700	
35.	"	"	" " " " "	600	251	349		711	9									1000	
36.	"	"	Hudson	604														1000	
37.	DeWitt No. 1	"	Dewitt	675	330	345		600										700	
38.	J. L. Pope	Ravenswood	J. L. Poe	600	368	232												373	
39.	Haymond No. 2	Union	Cairo Oil Co.	615														1084	
40.	" No. 1	"	Geo. Wolf	630	340	290												1034	
41.	W. M. Staats	Ravenswood	Staats et al.	600	400	200	2	1000		1450	50							1600	
42.	Barber	Union		565	363	203	4							1550	126	2155	20	2175	
43.	Rambo	"	Rambo	700	425	275						1514	53			2090	21	2503	
44.	Fisher	Ripley	Carter Oil Co	698				790	27	1160	80	1732	118	1910	65	2383	11	2480	
45.	Evans	Washington	" " "	698								1685	75	1760	100	2237	5	2430	
46.	Thomas	"			520					1475	20							1665	
47.	McWoodruff Shaft	Union			430													430	
48.	McConnell	"																500	
49.	Shinn Shaft	"			350													350	

Wells in Mason County.

The following is a summarized table of the wells and core drill holes in Mason county.

SUMMARIZED RECORD OF WELLS IN MASON COUNTY

No. on Map	Name of Well	Location—District	OWNER	Elevation	Pittsburgh Coal Depth (top)	Pittsburgh Coal Elevation (top)	Pittsburgh Coal Thickness	Cow Run Depth (top)	Cow Run Thickness	Salt Sand Depth (top)	Salt Sand Thickness	Big Lime Depth (top)	Big Lime Thickness	Big Injun Depth (top)	Big Injun Thickness	Berea Depth (top)	Berea Thickness	Total Depth	Producing Sand
1.	Beale	Clendennin		600		670				760	170	975	166	1550		1701	29	2870	
2.	Austin	"		620		625						1030	190					1843	
3.	Wagner	Lewis		615		590						990	110			1660	23	2224	
4.	Grimm	Union	Freeman	600														532	
5.	Kimberly	"	"	600	246	354												700	
6.	Thorton	"	"	630															
7.	John Stone	"	"	633	375	258												410	
8.	Geo. Kapp	"	"	605	375	230												550	
9.	Geo. Smith	"	"	622	384	238												391	
10.	O. J. Baker	"	"	610	244	366													
11.	B. Stone	"	"	565	160	405												382	
12.	McClure	Cologne	McClure	715														2200	
13.	Jeff Mitchell	"		680														2200	
14.	Culin	Cooper	Freeman	685														500	
15.	Swaats	"	"	650	384	266												401	
16.	Margarette Rousch	"		560	377	183												526	
17.	Sayres	"		575														2500	
18.	Hensley	Grant	Hensley	590	61	529	5'											641	
19.	Rickard	"	"	552	142	410	5' 3"											148	
20.	Hensley	"	"	580	121	459	5?											126	
21.	Sehan	"	"	580	84	496													
22.	Hensley	"	"	660	160	500													
23.	Nease	"	"	606	82	514													
24.	Hart	"	"	660	160	500													
25.	Rayburn	"	"		84		5												
26.	Butler	Hannan		595								1480	60	1565	285	2060	25	2220	
27.	Jas. A. Rayburn		Hensley	665	135	530	5											142	
28.	Jos. McMilian		"	638	110	528	3' 6"											116	
29.	Mrs. Rayburn		"	609	76	533	6?	580	25							1740	30	2228	
30.	Jos. Swan	Robinson	"	565												1591	30	1621	
31.	Sehan	"	"	620				266	10			965	100	1107	238	1640	30	1677	
32.	Devolt	Cologne		695	340	355							60	1530	263	1590		2124	
33.	Poplar Grove Farm	Clendennin	Barnes et al	615														801	
34.	J. B. Redmond	Arbuckle		585															
35.	Absten	Union	Freeman	600	321	279												446	
36.	Edgington	"	"	640	340	300													
37.	Jas. Morgan	Cooper	"	565	191	374													
38.	Ed Warner	Union	"	620	346	274												353	
39.	J. M. Ray	"	"	620	346	274												386	
40.	McClain	"	"	675	395	280												550	

Wells in Putnam County.

The following is a summarized table of the wells and core drill holes in Putnam county:

SUMMARIZED RECORD OF WELLS IN PUTNAM COUNTY

No. on Map	Name of Well	Location—District	OWNER	Elevation	Pittsburgh Coal			Cow Run		Salt Sand		Big Lime		Big Injun		Berea		Total Depth	Producing Sand
					Depth (top)	Elevation (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness	Depth (top)	Thickness		
1.	McAlister No. 2	Curry	H. O. & D. Co.	665						805	85			1524	66	2000	30	2036	Gas in Big Injun.
2.	Woodyard	"	" " " " "	750						830	26							856	Gas in Salt sand.
4.	Albert Maynor	"	" " " " "	765						230	53							897	" " " "
3.	McAlister No. 1	"	" " " " "	745						862	16							878	" " " "
5.	A. M. Alford	"	" " " " "	700						863		1313	215	1539	9	1559		1548	" " " "
6.	McAlister Heirs	"	" " " " "	710						808	16							826	" " " "
7.	P. A. McAlister	"	" " " " "	700						774	43							817	
8.	W. M. Grass	"	" " " " "	695						815	46							861	
9.	Harden	"	" " " " "	675						815	46			1595	40	2067	23	2090	Gas in Berea sand.
10.	Arbaugh	"	" " " " "	690										1540	35	2026	15	2041	
11.	J. E. McAlister	"	" " " " "	770						865	62							927	
12.	Carpenter	"	" " " " "	600															
13.	Stewart	Scott	Carter Oil Co.	592			3							1593		2055	19	2128	
14.	Simms No. 1		Guyan Oil Co.	610		786								1565	115	2066	20	2092	
15.	" " 2		" " "	640															
16.	Davis	Buffalo		600										1800		2274	22	2740	
17.	Cargill			597	35	565				1127		1421		1628	161	2291		2603	
18.	"			600										1667		2134		2603	
19.	Higganbottom	Union		700						1380	230	1610	27	1820	75			1895	
20.	Wolf	Buffalo		587	200														
21.	Ewers	"	Nash et al.															306	
22.	Handley Heirs	"	" " "				5?											206	
23.	Nash	"	" " "	600	52		3?												
24.	"	"			196	404													
25.	N. E. Smith	"	Donovan		204														
26.	Abney & Humphreys	Union	"		214														
27.	" " "	"		620														2895	
28.	" " "	"	Plymouth	620															
29.	" " "	"	"	654														1800	
30.	" " "	"	Freeman	660															
31.	" " "	Duval	H. O. & D. Co.	800															
32.	Robert Thompson	Teays Valley		615															
33.	Jas. Bridgmen	" "		620															
34.	Albert Ellis	" "		625															
35.	Abney & Humphreys	Union	Mitchell Freeman	695															
36.	Barnett	Buffalo	" "	635	317	318													
37.	Isaac Bays	Curry	Holley & Stephenson	801															
38.	G. L. Eggleson	"	South Penn Oil Co.	814															
39.	Robert Chaney	"	" " " "																
40.	Prichard	Pocatalico	Plymouth Co.	655															
41.	Harrison	"	" "	685	1165	538.5													
42.	E. B. Honnaker	"	" "	718	177	508													
43.	O. B. Honnaker	"	" "	740	243	475													
44.	Abney & Humphreys	"	" "		253	487													
45.	Silman	"	" "	664	164	500	6'6"												
46.	Abney & Humphreys	"	Abney & Humphreys		115	539	3'8½"												
47.	Farrar	"	Donovan		151														
48.	Abney & Humphreys	"	Plymouth	730	153	477	(?)												
49.	Smith Heirs	"	"	745	194	566													
50.	Honnaker	Union	"	705	262	483													
51.	Raines	"	"	590	272	318													
52.					280	310													
53.		Scott		700															
54.	Harbour	Teays Valley	H. O. & D. Co.	680										1700	100	2198	22	2220	
55.	H. O. Sowers	" "	United Fuel Gas Co.															1161	
56.	" " "	" "	" " " "															1375	
57.	East End Land Co.	" "	" " " "	780															
58.	" " " "	" "	" " " "															1135	
59.	L. H. Erskin	Scott	Local	650B															
60.	Davis	Curry	United Fuel Gas Co.	655L															
61.	Jas. L. McLain	Union	" " " "	715	250	465	5							1830	70	2326	16	2375	
62.	Abney & Humphreys	"	Freeman	690	390	300												405	
63.	Carney	"		770														1800?	

CHAPTER IX.

THE COAL RESOURCES OF THE JACKSON-MASON-PUTNAM AREA.

The geology, structure and general character of all the coals of the Jackson-Mason-Putnam area have already been described in detail in the preceding pages of this volume, and the purposes of this chapter are to consider the coal production, the chemical composition and the character of the workable coal beds more in detail, as well as the available coal area still unmined.

Statistics of Coal Production.

In the area embracing Jackson-Mason-Putnam counties the mining of coal on a commercial scale has been confined altogether to the Pittsburgh bed. In Jackson county, as already brought out in preceding pages, this coal, if present at all, lies buried below drainage over the entire area. In Mason county it comes above water level near Hartford, where it is mined along the Ohio river. In Putnam county it is mined at Raymond City, Black Betsey, Plymouth and Alpha.

The following tables have been compiled from the annual report of the Department of Mines of West Virginia for the year ending June 30, 1910, as given by Hon. John Laing, Chief of Department of Mines:

Table Showing the Coal Production of Mason and Putnam Counties From 1888 to 1910, Inclusive.

	Mason County.		Putnam County.	
Year.	Tons of 2240 lbs.	Tons of 2000 lbs.	Tons of 2240 lbs.	Tons of 2000 lbs.
1888	85,870	96,174	135,100	151,312
1889	126,797	142,013	107,325	120,204
1890	129,744	145,313	183,184	205,166
1891	116,598	130,590	156,856	175,679
1892	123,323	138,122	154,962	173,557
1893	141,104	158,036	197,733	221,461
1894	92,764	103,896	148,474	166,291
1895	171,074	191,603	122,057	136,704
1896	101,418	113,588	161,555	180,942
1897	111,535	124,919	131,522	147,305
1898	109,204	122,309	128,851	144,313
1899	106,867	119,691	164,004	183,684
1900	85,367	95,611	203,449	227,863
1901	98,427	110,238	125,321	140,360
1902	113,527	127,150	208,712	233,757
1903	102,282	114,556	178,904	200,372
1904	89,009	99,690	295,914	331,424
1905	77,846	87,188	310,576	347,845
1906	108,420	121,430	465,341	521,182
1907	93,211	104,396	401,413	449,583
1908	109,738	122,907	424,424	475,355
1909	106,802	119,618	378,420	423,830
1910	145,189	162,612	438,229	490,816
Totals	2,546,116	2,851,650	5,222,326	5,849,005

The same report gives the following table showing the relatives rank of Mason and Putnam counties in coal production compared with other counties of the State:

Order in the Production of Coal, 1897-1910.

Counties.	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
Fayette	1	1	1	1	1	1	2	1	2	2	2	2	2
McDowell ...	2	2	2	2	2	2	1	2	1	1	1	1	1
Marion	3	3	3	3	3	3	3	4	3	4	4	4	4
Kanawha ...	4	4	4	4	4	4	5	3	4	3	3	3	3
Mercer	5	5	5	6	6	6	6	6	6	6	6	6	6
Harrison ...	9	9	8	7	5	5	4	5	5	5	5	5	5
Tucker	6	6	7	5	7	7	7	8	8	8	10	10	10
Mingo	8	8	9	9	9	8	8	7	7	7	7	7	9
Mineral	7	7	6	8	8	9	11	11	12	13	14	13	11
Preston	13	11	10	10	10	10	9	10	10	9	9	11	13
Taylor	10	10	11	11	11	11	14	16	16	16	17	17	16
Marshall	11	12	12	12	13	16	13	14	14	15	15	18	19
Randolph ...	..	..	..	14	14	14	12	13	13	12	13	14	14
Barbour	19	19	17	18	12	12	10	9	11	11	11	12	12
Raleigh	16	16	16	19	17	13	15	12	9	10	8	8	8
Putnam	**12**	**13**	**13**	**13**	**15**	**15**	**16**	**15**	**15**	**14**	**18**	**16**	**17**
Ohio	15	15	14	15	16	17	18	19	21	22	21	21	21
Brooke	17	18	18	20	20	20	23	22	17	17	16	15	15
Mason	**14**	**14**	**15**	**16**	**18**	**19**	**19**	**20**	**22**	**21**	**22**	**22**	**22**
Grant	..	..	..	..	..	..	22	18	19	19	20	20	20
Logan	..	..	..	..	..	..	..	..	20	18	12	9	7
Monongalia .	20	17	19	17	19	18	17	17	18	20	19	19	18
Hancock	18	20	20	21	21	21	20	21	24	24	23	25	26
Clay	..	..	..	..	..	..	..	25	23	23	24	27	30
Nicholas	..	..	..	..	..	22	24	24	25	25	25	26	27
Lincoln	..	..	..	..	..	23	21	23	27	26	30	30	25
Braxton	..	..	..	..	..	..	..	..	..	..	26	23	23
Wayne	..	..	..	..	..	..	..	..	26	27	29	29	28
Upshur	..	..	..	..	..	..	..	..	..	28	27	24	24
Greenbrier ..	..	..	..	..	..	..	..	..	..	..	28	28	29
Lewis	..	..	..	..	..	..	..	..	..	..	31	31	32
Gilmer	..	..	..	..	..	..	..	..	..	..	32	32	31
Wyoming ...	..	..	..	..	..	..	..	..	..	..	..	33	34
Boone	..	..	..	..	..	..	..	..	..	..	..	..	33

The following table compiled from the same report, page 16, gives the coal production of Mason and Putnam counties for the year 1909:

PRODUCTION OF COAL FOR THE YEAR 1909.

NAME OF COMPANY	NAME OF MINE	Production of Coal. (Tons of 2,000 lbs.)			Distribution of Coal. [Tons of 2,000 lbs.]		
		1st Six Months	2d Six Months	Total Production for Year.	Used in Operation of Mine.	Furnished Local Trade & Tenants	Quantity Shipped from Mine
Mason County.							
Mason City Coal Mining Co.	Klondike and Linden.	31,645	21,546	53,191	....	1,443	51,748
Consumers Coal & Mining Co.	Camden	4,919	2,887	7,806	959	5,247	1,600
Beech Grove Coal Co.	Beech Grove	7,533	1,745	9,278	....	100	9,178
Liverpool Salt & Coal Co.	Jackson	10,117	7,486	17,603	....	....	17,603
Hartford Coal & Mining Co.	Hartford	11,200	16,900	28,100	1,799	273	26,028
Dixie Coal Works	Dixie	2,008	2,632	3,640	120	320	3,200
Totals	....	67,422	53,196	119,618	2,878	7,383	109,357
Putnam County.							
Plymouth Coal & Mining Co.	Plymouth	2,081	2,943	5,024	....	....	5,024
Plymouth Coal & Mining Co.	Manilla	29,616	31,209	60,825	1,762	1,198	57,865
Plymouth Coal & Mining Co.	California	30,887	32,410	63,297	1,761	1,198	60,338
Alpha Coal Mining Co.	Alpha	1,000	1,000	2,000	80	....	1,920
The Otto Marmet Coal & Mining Co.	Big Otto Nos. 1, 2 & 3.	78,749	88,637	167,386	....	1,475	165,911
Black Betsy Coal & Mining Co.	Nos. 1 and 2	59,463	60,246	119,709	....	7,999	111,710
Oak Forest Coal & Mining Co.	Oak Forest	2,949	2,640	5,589	221	440	4,928
Totals	....	204,745	219,085	423,830	3,824	12,310	415,696

2. Sketch map showing approximate area of Pittsburgh coal in Mason and Putnam counties.

COALS OF THE JACKSON-MASON-PUTNAM AREA.

There are possibly two seams of workable coal in the area under discussion. Many of the coal beds so rich in other portions of the Appalachian Field are thin and quite frequently absent here.

The most important coal is the **Pittsburgh seam,** which rises above the surface along the Ohio river at Hartford and is mined in Mason county, and also in Putnam.

The **Lower Freeport coal** may be of workable thickness in some of the area, and also the Kittanning coal, but their horizons are deeply buried below drainage level, and hence nothing definite is known either of their thickness or extent. The general description and stratigraphy of these coals have already been given in the preceding pages, while the chemical composition, heating value and detailed structure of the seams at the several mines, whether commercial or local domestic, form the subject of this chapter.

The chemical analyses and determination of heating values, given in the following pages were made by J. B. Krak, Assistant Chemist of the Survey, under the supervision of Professor B. H. Hite, Chief Chemist.

The coals were sampled by the writer and where possible a sample was obtained by digging down a section of the coal entirely across the face of the bed, excluding only such slates and partings as are taken out in mining operations. In the commercial mines, these samples were crushed and quartered down to two or three pounds of coal, placed in tin cans hermetically sealed, and sent to the laboratory of the Survey. The same methods of analysis were used as by the Fuel Testing Department of the United States Geological Survey.

The calorific value of the coals analyzed for this report is expressed in terms of British Thermal Units, the unit of heat measurement more commonly used in the United States. This unit of heat usually marked **B. T. U.**, represents the amount of heat required to raise one pound of water one degree Fahrenheit in temperature. For instance, on page 270, the table of coal analyses shows the Pittsburgh coal at Hartford to have

13,391 B. T. U. for one pound of coal. The Pittsburgh bed in the Fairmont region gives from 14,000 to 14,400 B. T. U. for each pound of coal, and the New River and Pocahontas coals run from 15,000 to 15,500 B. T. U.

Along with both the proximate and ultimate analysis is also given the B. T. U. result as well as the ratio of the total carbon to the oxygen plus ash. It has only recently been insisted upon that oxygen has about the same deteriorating effect as ash in a coal and the above mentioned ratio, proposed by Mr. David White of the National Museum and United States Geological Survey, is the best yet devised for the classification of coals in order to show their relative rank in heating values.

The coals in the different series will now be described in descending order.

THE COALS OF THE DUNKARD SERIES.

The Washington Coal.

This coal is very thin throughout the area, and quite frequently entirely absent, or if present is only represented by a black slate, and the persistent Washington shales which lie underneath same. While there are a few places where it was possible to get a measurement of the thickness of this coal, as already given, yet it is so thin that it is of no commercial value, and it would be difficult to calculate the area or tonnage of the seam. The coal at best is very impure, and will only be mined when all the richer and thicker seams of coal have been exhausted.

Dr. I. C. White in Volume II (A), West Virginia Geological Survey, pages 693-694, gives the following concerning these impure coals:

"This grade of fuel is, of course, not now marketable, since its heat units can best be rendered available through the agency of producer gas and the gas engine which have not yet come into general use, although each ton of this impure

coal when so utilized will produce more power, according to the determinations of the Technologic Branch of the United States Geological Survey, than a ton of the purest New River or Pocahontas coal, when the steam engine is the agency of conversion.

"When our best coals become more expensive to win, the State will have a large reserve of these poorer grades of fuel which will doubtless then be utilized for power and thus greatly prolong the life of West Virginia's coal fields, since, as may be observed from the details given in this volume, there is a large amount of impure coal, so interstratified with the purer layers in nearly every mine, that its precious carbon is now utterly lost, because there is no market for impure coals."

COALS OF THE MONONGAHELA SERIES.

The Waynesburg Coal.

The Waynesburg coal lies at the top of the Monongahela series. A detailed description of this coal has already been given.

This coal like the Washington coal is of little commercial value, in the Jackson-Mason-Putnam area; in fact, it is almost always absent and not even represented by black slate, as shown in the core drill holes already given. In southern Jackson county a few openings have been made and the coal mined, as shown in the preceding pages, but as the bed is very thin and impure, it would be hard to estimate the amount of available coal in this seam.

The Uniontown and Sewickley Coals.

The Uniontown and Sewickley coals are almost entirely absent from the area under discussion in this volume, as shown from the sections and core drill holes published in the preceding pages, unless it could be possible that the coal bed identified as the Waynesburg could represent the Uniontown seam.

The Redstone Coal.

The Redstone coal appears to be entirely absent from this area, although Professor Bownocker of the Ohio State Geological Survey, thinks the coal mined in Mason county is this coal; however, it is classified in this volume as the Pittsburgh coal for reasons given in the preceding pages.

The Pittsburgh Coal.

The coal of economic importance in the Jackson-Mason-Putnam area is the great Pittsburgh seam which as it rises above the Ohio river at Hartford becomes thick enough to mine in Mason and Putnam counties.

The distribution of this coal has already been described in the preceding pages, and hence the character and composition of the Pittsburgh bed in the mines where it is operated will now be considered.

Mines in Mason County.

Coal has long been mined in Mason county near Mason City, where it has been used as a fuel in the manufacture of salt, and already several small mines that have been in operation for many years are now idle or exhausted. The mines that are in operation in 1910 in Mason county, north of Point Pleasant, are the following: Hartford Coal and Mining Company, Liverpool Salt and Coal Company, Hutchinson Coal Company, and the Harris Coal Company.

Hartford Coal and Mining Company.

This company operates a mine located at Hartford on the Ohio river. The writer collected a sample for analysis and measured the following section in the mine:

	Ft.	In.		
Sandstone				
Slate	0	2		
Coal	0	½		
Slate (impure)	2	0		
Coal } Top coal	0	6		
Bone coal } Top coal	0	1		
Coal, hard	1	2	4′	5″
Bone coal	0	1		
Coal, hard	2	7		

The elevation of the opening is 540′ A. T. (Aneroid). The greatest rise, N. 30° W.; mine capacity, 150 tons in eight hours, and fifty men employed in mine. The coal is used mostly for domestic fuel, and for steam, being shipped west. The "Top coal" is left in the mine, since it is impure, and it also protects the slate roof; but where the slate is absent and the sandstone comes to the coal then this coal is mined.

The Liverpool Salt and Coal Company.

The Liverpool Salt and Coal Company has a mine at Hartford in the Pittsburgh bed, and its output is about 200 tons of coal daily. The elevation of the coal is 583 feet A. T. (Aneroid). They have sixty men employed in their mine. The coal is used for domestic fuel and steam purposes. Shipments are made by rail. The writer collected a sample for analysis and measured the following section:

	Ft.	In.		
Sandstone				
Slate	2	0		
Coal, impure	0	6		
Bone coal	0	6		
Coal, hard	1	2	4′	9″
Bone coal	0	1		
Coal, hard	2	6		

The coal is screened and the slack coal is used in the salt furnaces for the manufacture of salt, while the lump coal is shipped by rail.

The Hutchinson Coal Company.

The Hutchinson Coal Company operates a mine at Mason City, where the writer measured the following section and obtained a sample for analysis:

	Ft.	In.	
Massive sandstone			
Slate	1	0	
Coal, "top"	0	10	
Bone coal	0	2	4′ 10″
Coal, hard	3	10	

Elevation of mine, 590′ A. T. (Aneroid); greatest rise, N. 30° W.; mine capacity, 500 tons in eight-hour day; one hundred and twenty-five men employed in the mine; coal shipped west for fuel and steam purposes. The "Top coal" in the above section is mined and shipped.

The Harris Coal Company.

The Harris Coal Company operates a mine at Spilman, Waggener district. The writer obtained a sample and measured the following section:

	Ft.	In.	
Sandstone, massive			
Slate	2	0	
Coal, impure	0	4	
Slate	1	1	
Interlaminated coal and slate	2	0	Roof coal
Slate	0	8	4′ 9″
Coal and slate, interlaminated	0	6	
Slate	0	2	
Coal, impure	0	6	Main bench
Slate	0	½	4′ 5″
Coal	3	10½	

Elevation of surface, 630′ A. T. (Aneroid); greatest rise, N. 30° W.; mine capacity, 150 tons in eight-hour day; sixty men employed in the mine; coal shipped west for domestic and general fuel; shipments all made by rail.

Several more mines were formerly operated along the Ohio river, but they had small leases on the front and soon exhausted their coal or for some other causes have ceased operations.

This coal has also been mined for nearly fifty years in a small way for local fuel purposes in the vicinity of Point Pleasant and transported to market in wagons.

Rankin Hill Mine.

On Three Mile creek of Kanawha river, Arbuckle district, the writer measured the following section and obtained a sample of the coal for analysis from a mine operated by Rankin Hill:

	Ft.	In.		
Sandstone, massive				
Slate	4	0		
Draw slate	0	2		
Bone coal	0	2	2′	6″
Coal, hard	2	2		
Slate	0	2		
Fire clay	0	10		

Elevation of mine, 595′ A. T. (Aneroid): three men employed in the mine; capacity of mine, 10 tons daily.

There are several other coal openings on Three Mile creek, but they had fallen in and it was impossible to get the exact thickness of the bed.

The John Arrington Coal Opening.

Another measurement of this coal was taken at an old opening in John Arrington's field, Clendenin district, one-fourth mile north of Gallipolis Ferry, as follows:

	Ft.	In.		
Sandstone, massive				
Slate top	2	0		
Bone coal	0	4	2′	6″
Coal	2	2		
Fire clay floor				

Elevation of coal 720′ A. T. (Aneroid).

The William Harper Coal Opening.

An opening in the Pittsburgh coal on the farm of William Harper, one-fourth mile east of Beals, Clendenin district, shows the following section:

	Ft.	In.
Sandstone		
Slate	4	0
Coal	2	2
Fire clay floor		

Elevation of surface, 683 feet. Coal was formerly mined here for local use.

COAL MINES IN PUTNAM COUNTY.

The exploitation of the coals in Putnam county began about 1855, but little was accomplished until 1865 at the close of the Civil War.

The following mines are now in operation in the Pittsburgh bed: The Otto Marmet Coal and Mining Company, The Black Betsey Coal and Mining Company, The Plymouth Coal and Mining Company, and the Alpha Mining Company.

The Otto Marmet Coal and Mining Company.

The Otto Marmet Coal and Mining Company has been mining coal at Raymond City for more than forty years, shipping coal by rail and river to the southern and western markets, and has for years had an enormous trade in the Cincinnati market, where its coal is used for domestic fuel, and general steam purposes.

The following section was measured and a sample of the coal taken at the Otto Marmet Mine:

	Ft.	In.		
Sandstone roof				
Slate	1	6	Roof coal	
Bone coal	0	5		
Slate	0	2		
Bone coal	0	4		
Slate	0	3	3′	3″
Coal and slate (interlaminated)	0	6		
Slate	0	1		
Coal, impure ("Moonshine")	1	0		
Draw slate	0	6		
Bone Coal	0	2		
Coal, hard	5	6	6′	0″
Bone coal	0	4		
Fire clay				

Elevation of main drift on Pocatalico river, 715′ A. T. (Barometer); greatest rise, S. 30° E.; mine capacity, 800 tons daily of eight hours. There are one hundred and seventy-five men employed in the mine.

The Black Betsey Coal Mining Company.

The Black Betsey Coal Mining Company operates a mine at Black Betsey, one mile and a half northwest of Raymond City, where the writer measured a section and secured a sample of coal for analysis:

			Ft.	In.		
Sandstone roof						
Coal and slate, interlaminated			0	6		
Coal			0	2		
Slate			0	8	4′	1″
Coal, impure (Moonshine)			1	10		
Slate			0	11		
Coal, hard	1′	3″				
Bone coal	0′	1″				
Coal, hard	2′	0″				
Bone slate	0′	2″	5	8¼		
Coal, soft	1′	2″				
Slate	0	¼				
Coal, splint	1	0				
Fire clay floor						

Elevation, 640′ A. T. (Spirit Level); greatest rise, S. 30° E.; mine capacity 600 tons daily of eight hours. There are one hundred and fifty men employed in the mine. The coal is shipped by river and rail, both south and west, and is used for domestic fuel and also steam purposes.

The Plymouth Coal Mining Company.

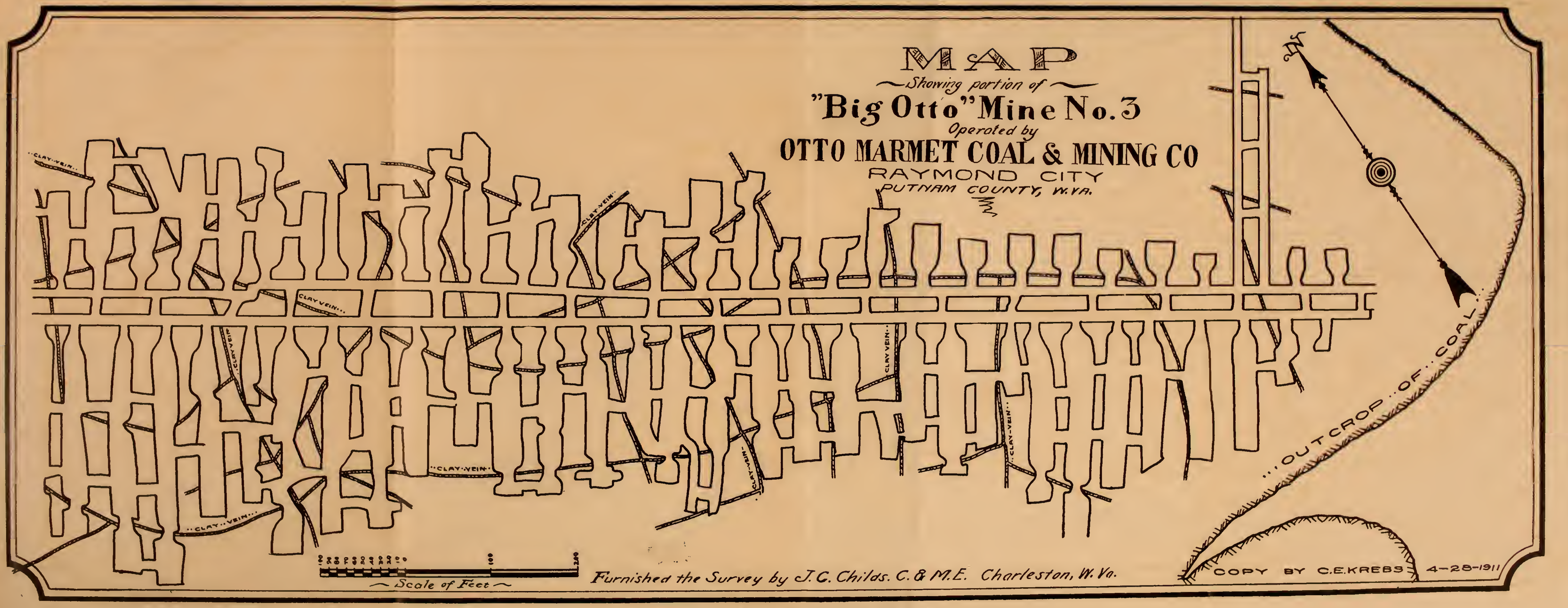
The Plymouth Coal Mining Company operates a mine two miles and three-fourths northwest of Raymond City. The following section was measured and a sample of coal for analysis was collected by the writer from the seam worked:

	Ft.	In.	
Sandstone roof			
Coal and slate, interlaminated	0	6	Roof coal 4′ 0″
Coal	0	2	
Slate	0	6	
Coal, impure (Moonshine)	1	10	
Slate	1	0	
Coal, hard	1	3	5′ 10½″
Bone coal	0	2	
Coal, hard	2	0	
Bone coal	0	2	
Coal, soft	1	3	
Slate	0	½	
Coal, splint	1	0	
Fire clay floor			

Elevation of surface, 620′ A. T. (Aneroid); greatest rise, S. 30° E.; mine capacity, 500 tons daily of eight hours. There are one hundred and forty men employed in the mine. The coal is shipped west and south by rail and river and used for domestic fuel and steam purposes. The bottom splint coal is left in the mine to protect the floor, since the fire clay underneath the coal is very soft and as soon as water is mixed with it, the haulways become impassable.

The Alpha Coal Mining Company.

The Alpha Coal Mining Company (now idle) is located one mile north of Plymouth on Guano creek and formerly operated in the Pittsburgh coal. The mine was idle when the writer visited it (1910), but a few men were employed in mining coal for domestic fuel to be sold to the farmers in Putnam county and hauled many miles. The writer measured the following section and obtained a sample for analysis:



3. Sketch showing map of clay veins in the Pittsburgh coal.

	Ft.	In		
Sandstone roof				
Slate	3	0		
Coal	2	0		
Bone coal	0	½	2′	6½″
Coal	0	6		
Fire clay	3	0		

Elevation of surface, 625′ A. T. (Aneroid); greatest rise, S. 30° E.; four men employed in the mine; capacity, 6 tons daily.

The method of mining this coal in the "Poca" district is the "Room and Pillar" system, without laying off the territory into panels. Also the rooms are driven about 45 feet from center to center and from 28 to 32 feet wide, leaving only about 35 per cent of the coal in pillars to support the roof. These pillars are not to be recovered until the entire length of the entry is worked out, as the floor of the coal is fire clay of a thickness of from 2 feet to 8 feet and very soft and mobile. The pillars do not sustain the weight of the overlying strata well and quite frequently a "squeeze" is formed and much of the coal is lost beyond recovery.

It is difficult to determine just what amount of coal is left in the mines and what per cent is actually recovered, but from observations and examinations made by the writer, he concludes there is probably not more than 60 to 65 per cent of the coal recovered, and if all the impure layers of the coal are taken into consideration, there is probably not more than 50 per cent of this seam actually recovered. In order to recover more of the coal, it will be necessary to adopt some other methods of mining than those now used by the operating companies.

Stewart Opening.

An opening in the Pittsburgh coal was once made on land owned by Hon. James H. Stewart, opposite Raymond City, where the coal was mined for local use. The opening has fallen in, and it was impossible to measure a section of the coal, but it was reported to be 40″ thick with some slate.

Several small openings have been made in the Pittsburgh seam of coal on Hurricane creek between the Kanawha river and Hurricane station on the Chesapeake & Ohio Railroad, among which are the following:

Holley Opening.

A small mine for domestic fuel is operated by James Holley on Hurricane creek, Teays Valley district, S. 80° W., six miles and a half from Winfield, where the following section was measured and a sample collected by the writer for analysis:

	Ft.	In		
Sandstone				
Slate with limestone nodules	3	0		
Coal	1	0		
Slate	0	1	2′	1″
Coal	1	0		
Fire clay bottom				

Elevation of surface, 645′ A. T. (Aneroid); greatest rise, S. 30° E.; two men employed in the mine, and it has a capacity of from 4 to 6 tons daily, the product being hauled away in wagons, principally by the farmer.

Hodges Mine.

Everett Hodges operates a small mine for local use, one mile northeast of the Holley mine on Hurricane creek, Teays Valley district, where the writer measured the following section and obtained a sample for analysis:

	Ft.	In		
Sandstone roof				
Slate and fire clay	4	0		
Draw slate	0	2	2′	2″
Coal	2	0		
Fire clay floor				

Elevation of surface, 630′ A. T. (Aneroid); capacity of mine, 4 tons daily; two men employed in the mine and the coal is hauled away in wagons.

4. Sections of Clay Veins.

Several other small openings were formerly operated on this creek, and fuel supplied to Hurricane, but in recent years since gas is used as a fuel in that town, these mines have been discontinued.

The coal on Hurricane creek is variable in thickness, ranging from 6 inches to 3 feet, underlaid with a very soft layer of fire clay from 6 inches to 2 feet in thickness. Some of the farmers living in the vicinity near where the coal has been mined, informed the writer that it often attains a thickness of 4 feet; but the writer failed to find any coal of that thickness.

Another feature that extends into the coal area north of the Kanawha river from Raymond City to Plymouth is a "fault," or "want" about one mile in width extending nearly paralled to the river, where the coal has been changed into black bituminous slate of the same thickness as the coal. Several of the operating companies were forced to tunnel through this slate in order to find the coal.

Clay Veins.

Another feature which makes the mining of coal difficult and expensive in this field is the **clay veins** occurring in the coal. Their occurrence is irregular in regard to course, distance and shape. Mr. John Childs, a mining engineer of Charleston, West Virginia, has kindly furnished the Survey with a map, Figure 1, showing a portion of the mine workings of the mine of the Otto Marmet Coal and Mining Company. On this map he has carefully traced in the clay veins as they occur, showing that the course of some of them is almost due north and south, while the course of others is almost at right angles to these, or nearly east and west. No exact distances appear to separate them, yet from the sketch given they range from 100 to 200 feet apart.

These veins sometimes occur in the roof and extend into a portion of the coal, and frequently they rise from the bottom and extend nearly to the top of the coal seam; and at times extend through the whole seam, ranging in thickness from a few inches to several feet.

The clay veins are composed of fire clay and are often very hard and quite frequently contain some sulphureted hydrogen gas as well as methane or marsh gas.

The accompanying sections show (Figure 2) the shape in which some of these veins are found.

QUANTITY OF PITTSBURGH COAL AVAILABLE.

It is difficult to make an accurate estimate of the amount of available tonnage of the Pittsburgh coal bed in the area under discussion for the reason that not all the territory has been fully tested, since much of the total lies below water level and can only be developed with core drill holes.

In the preceding pages are records of different core drill holes that have been sunk to and through the Pittsburgh coal, copies of which have been furnished the Survey, and from these records the writer has shown on the Economic Geology Map the approximate boundary line of the workable Pittsburgh coal in Putnam and Mason counties where the coal is 2 feet 6 inches and over. In Jackson county no data were available as to the thickness of the Pittsburgh coal, except one core drill hole at Bar run, two miles south of Ravenswood, which showed this coal to be 3 feet 9 inches thick. Just how much coal of that thickness is available in Jackson county cannot be determined and the writer will not attempt any estimate of it, but the quantity is most probably small.

An approximate determination of the area of that portion of Mason and Putnam counties has been made by districts within the boundary lines shown on the Economic Geology Map and the area of the coal calculated.

Mason County.

	Sq. Miles.
Union District	8.6
Grant District	21.30
Waggener District	16.35
Robinson District	11.00
Cooper District	9.75
Total	67.00

Putnam County.

	Sq. Miles.
Pocatalico District	27.00
Buffalo District	1.00
Union District	41.00
Total	69.00

Assuming the average thickness of the coal in Mason county as 4 feet 6 inches, and the average thickness in Putnam county as 5 feet 6 inches, as taken from the different measurements, we are able to get the following results:

TABLE SHOWING AVAILABLE PITTSBURGH COAL IN THE AREA.

County.	Sq. Mi.	Acres.	Cu. Ft. of Coal.	Short Tons of Coal.
Mason	67.00	42,880	8,405,337,600	336,213,504
Putnam	70.00	44,800	10,733,184,000	429,327,360
Totals	137.00	97.680	19,138,521,600	765,540,864

In order to obtain the above results, it is assumed by the writer that one cubic foot of Pittsburgh coal weighs 80 pounds. These figures are the same as obtained for the weight of the Pittsburgh coal at the Fuel Testing Plant of the United States Geological Survey at St. Louis, Missouri.

LITTLE PITTSBURGH COAL IN MASON COUNTY

William Porter Mine.

Mr. William Porter has a small mine located on Sixteen Mile creek, one mile east of Mercer Bottom, Hannan district, which he operates and furnishes coal for domestic fuel. In order to operate this mine he has sunk a shaft for 40 feet through the overlying strata. The writer was able to get the following section and sample of coal for analysis from this mine:

	Ft.	In.	
Sandstone			
Slate	7	0	
Coal, hard, good quality (roof)	1	6	Roof
Slate	2	6	4′ 9″
Coal, hard	0	6	
Shale, fire clay	0	10	Main Bench
Bone coal	0	4	5′ 2″
Coal, hard splint	3	6	
Slate floor			

Elevation of surface, 545′ A. T. (Aneroid); three men employed in the mine: capacity of the mine, 10 tons per day of 10 hours; sample of coal taken from No. 8 in the above section for analysis.

The W. J. Keester Mine.

Mr. W. J. Keester operates a small mine for local use, one-half mile southeast of the mine operated by William Porter. The coal in this mine is reached by means of a slope. The writer measured the following section and collected a sample of the coal for analysis:

	Ft.	In.	
Slate			
Coal	0	3	
Slate	0	2	
Coal	0	2	
Slate	0	1	
Coal	0	1	
Slate	0	4	Roof Coal
Coal	0	1	3′ 8″
Slate	0	2	
Coal	0	7	
Slate	0	3	
Coal	0	6	
Slate or fire clay	1	0	
Bone coal	0	4	Main Bench
Coal	3	5	3′ 9″
Fire clay bottom			

5. Sketch map showing approximate area of Little Pittsburgh coal in Mason and Putnam counties.

THE LITTLE PITTSBURGH COAL IN PUTNAM COUNTY.

This seam of coal is mined south of the Kanawha river at Oak Forest and also has been mined near the mouth of Hurricane creek by the Big Hurricane Coal Company (not now in operation).

Oak Forest Coal Company.

The Oak Forest Coal Company is operating a mine on the south side of Kanawha river, about three miles west of Winfield, Scott district. The writer measured the following section and obtained a sample of coal for analysis from the seam worked:

	Ft.	In.		
Sandstone				
Slate, with limestone nodules............	1	0		
Coal, hard splint	2	6		
Coal, gas	0	10	4′	1″
Slate	0	1		
Slate and coal interlaminated	0	8		

Elevation of mine 510′ A. T. (Aneroid); coal used for steam and domestic fuel, and shipped by river to local and southern markets.

Big Hurricane Coal Company.

The mine operated by this company is located about one mile west of Oak Forest Mine, but has now suspended operations (1910). The writer was able to obtain the following section and also a sample for analysis from said mine:

	Ft.	In.		
Sandstone				
Slate	3	0		
Coal and slate, laminated	0	6		
Slate with limestone nodules	1	6		
Slate	0	6		
Coal, hard	2	4		
Coal, gas	0	8		
Slate	0	½	3′	6½″
Coal	0	6		

Fire clay bottom.
Elevation of surface, 560′ A T. (Aneroid.)

Quantity of Little Pittsburgh Coal Available.

It is not easy to make even an approximate estimate of the available tonnage of the Little Pittsburgh bed in Mason and Putnam counties, since it appears from its occurrence that this coal lies in "pockets" or basins and just how much of this coal is available cannot be determined until their areas have been more thoroughly prospected.

The writer has assumed that one square mile of coal is available at Oak Forest, Putnam county, and possibly the same amount at Mercer Bottom in Hannan district, Mason county, and assuming the thickness of the coal to be 3 feet 6 inches, arrives at the following results:

Table Showing Available Little Pittsburgh Coal.

County.	Sq. Mi.	Acres.	Cu. Ft. of Coal.	Short Tons of Coal.
Mason	1.00	640	94,074,400	3,762,976
Putnam	1.00	640	94,074,400	3,762,976
Totals	2.00	1280	188,148,800	7,525,952

THE COALS OF THE ALLEGHENY SERIES.

From the meager data at hand it is impossible to give an approximate calculation of the amount of available tonnage of coal in the Allegheny series, as only two core drill holes have penetrated through this series; viz., the core drill hole on the Poplar Grove farm, Mason county, and given on page 77 of this volume, and the core drill hole on the Lerner farm, given on page 169 of this volume. In the former core drill hole both the Freeport coals are thin and of little value, the Upper Freeport being absent and only represented with coal 1 foot 11 inches, and black slate 7 feet. It is possible that the Middle Kittanning coal may develop to be of workable thickness throughout some of the area, as it shows the following section in the Poplar Grove core drill hole:

Coal	3′
Slate	7′
Coal	2′

In the Lerner hole it shows a thickness of 5 feet 7 inches. Then also some of the oil well records show different thicknesses where they pass through this seam, but as it is difficult to determine whether it was slate or coal through which these wells passed, it would be impossible to estimate just how much good coal there was in each of these well records. From this meagre information the writer cannot attempt to estimate the amount of available coal tonnage in the Allegheny coal series.

Summary of Available Coal in the Three Counties.

	Short Tons.
Pittsburgh coal	765,540,866
Little Pittsburgh coal	7,525,952
Total	773,066,818

The above estimate of available coal left unmined in the Jackson-Mason-Putnam area does not necessarily indicate that such amount will be eventually taken out, since, as already stated, where the Pittsburgh coal in mined in this territory the percentage of coal recovered under present mining conditions and methods of mining, not counting the bottom coals often left untouched or the roof coals also not mined, varies in West Virginia from 60 to 90 per cent. If these roof coals were taken into consideration in the mines in Putnam county, where the coal is mined, it is doubtful if more than 55 per cent of the total coal in the Pittsburgh bed is recovered; but if the roof and bottom coals are discarded and more modern methods of mining adopted in the fields, the writer believes that about 80 per cent of this coal can be recovered. Figuring on this basis, then the total available coal tonnage in the counties of Jackson, Mason and Putnam would be in round numbers, 618,453,000 tons.

The following table gives the results of analysis and heat determination on the coals of this area:

ANALYSES OF COALS IN JACKSON, MASON AND PUTNAM COUNTIES.

Serial No.	MINE	COUNTY	HORIZON	Condition of Sample	PROXIMATE				COMMON TO BOTH		ULTIMATE				Calorimeter B. T. U. for 1 lb. of Coal.	Calculated B. T. U. for 1 lb. of Coal.
					Moisture	Volatile Matter	Fixed Carbon	Phosphorus	Ash	Sulphur	Carbon	Hydrogen	Oxygen	Nitrogen		
1.	Oak Forest......	Putnam..	Little Pittsburgh..	A. D.*	3.21	39.10	50.91	0.044	6.78	2.96	71.51	4.79	12.70	1.26	13106	12511
2.	" "	" ..	" " ..	A. R.*	3.50	38.98	50.76	0.044	6.76	2.95	71.30	4.80	12.93	1.26	13066	12473
3.	Porter..........	Mason...	" " ..	A. D.	4.24	37.79	49.55	0.029	8.42	4.22	67.67	4.92	13.57	1.20	12619	12016
4.	"	" ...	" " ..	A. R.	4.43	37.72	49.45	0.029	8.40	4.21	67.54	4.93	13.72	1.20	12594	11991
5.	Hurricane.......	Putnam..	" " ..	A. D.	3.10	38.97	50.83	0.050	7.10	2.12	72.63	5.22	11.66	1.27	13112	12981
6.	"	" ..	" " ..	A. R.	3.29	38.89	50.73	0.050	7.09	2.11	72.48	5.23	11.82	1.27	13086	12955
7.	Keester.........	Mason...	" " ..	A. D.	2.84	39.56	50.04	0.074	7.56	4.03	70.42	4.77	12.17	1.05	12804	12421
8.	"	" ...	" " ..	A. R.	3.93	39.12	49.48	0.073	7.47	3.98	69.64	4.83	13.04	1.04	12660	12281
	Average......	....	....	....	3.57	38.76	50.22	0.049	7.45	3.32	70.40	4.94	12.70	1.19	12881	12454
9.	Hartford........	Mason...	Pittsburgh.........	A. D.	3.06	41.06	50.89	0.030	4.99	1.57	73.82	5.43	13.00	1.19	13391	13163
10.	"	" ...	"	A. R.	5.96	39.83	49.37	0.029	4.84	1.52	71.61	5.60	15.27	1.16	12991	12769
11.	Liverpool.......	" ...	"	A. D.	3.31	37.97	53.70	0.017	5.02	0.91	73.78	5.17	13.89	1.23	13447	12901
12.	"	" ...	"	A. R.	4.59	37.47	52.99	0.017	4.95	0.90	72.81	5.24	14.88	1.22	13269	12730
13.	Harris..........	" ...	"	A. D.	2.97	41.36	46.90	0.037	8.77	3.22	70.15	4.98	11.74	1.14	12841	12510
14.	"	" ...	"	A. R.	5.14	40.43	45.86	0.036	8.57	3.14	68.59	5.11	13.47	1.12	12553	12229
15.	Linden..........	" ...	"	A. D.	4.35	38.96	50.37	0.025	6.32	1.24	74.35	4.65	12.20	1.24	13198	12805
16.	"	" ...	"	A. R.	7.03	37.88	48.95	0.024	6.14	1.21	72.26	4.83	14.35	1.21	12828	12446
17.	Holley..........	Putnam..	"	A. D.	2.70	39.40	52.18	0.025	5.72	2.81	73.76	4.82	11.57	1.32	13277	12938
18.	"	" ..	"	A. R.	5.38	38.32	50.74	0.024	5.56	2.73	71.73	4.99	13.71	1.28	12911	12582
19.	Rankin Hill.....	Mason...	"	A. D.	3.00	38.91	50.24	0.040	7.85	2.22	71.16	4.97	12.63	1.17	12967	12542
20.	" "	" ...	"	A. R.	4.45	38.33	49.49	0.039	7.73	2.19	70.09	5.07	13.77	1.15	12773	12354
21.	Hodges..........	Putnam..	"	A. D.	2.79	40.06	49.12	0.026	8.03	3.34	71.86	4.42	11.20	1.15	13156	12459
22.	"	" ..	"	A. R.	4.10	39.52	48.46	0.025	7.92	3.29	70.89	4.51	12.25	1.14	12979	12291
23.	Raymond City..	" ..	"	A. D.	1.97	38.32	54.02	0.055	5.69	1.26	75.50	5.14	11.01	1.40	13960	13370
24.	" " ..	" ..	"	A. R.	3.01	37.92	53.45	0.054	5.62	1.24	74.71	5.20	11.84	1.39	13812	13228
25.	Black Betsy....	" ..	"	A. D.	1.66	40.45	51.95	0.032	5.94	0.67	75.33	5.14	11.61	1.31	13792	13272
26.	" "	" ..	"	A. R.	3.17	39.83	51.16	0.031	5.84	0.66	74.19	5.23	12.79	1.29	13581	13069
27.	Plymouth.......	" ..	"	A. D.	1.86	38.12	53.94	0.033	6.08	2.14	74.61	4.87	10.99	1.31	13441	13109
28.	"	" ..	"	A. R.	3.66	37.42	52.95	0.032	5.97	2.10	73.24	4.98	12.43	1.28	13194	12868
29.	Alpha...........	" ..	"	A. D.	2.37	38.35	51.93	0.018	7.35	2.49	72.70	4.86	11.47	1.13	13362	12801
30.	"	" ..	"	A. R.	2.86	38.16	51.67	0.018	7.31	2.47	72.34	4.89	11.87	1.12	13294	12736
	Average......	....	....	....	3.61	39.00	50.93	0.030	6.46	1.97	72.70	5.01	12.63	1.23	13228	12781
31.	Black Betsey....	Putnam..	Pittsburgh......... (Bituminous Slate)	A. D.	1.74	35.11	44.74	0.055	18.41	0.67	63.79	4.67	11.31	1.15	11823	11327
32.	" "	" ..	" "	A. R.	1.93	35.05	44.65	0.055	18.37	0.66	63.68	4.68	11.47	1.14	11801	11306
	Average......	....	....	....	1.83	35.08	44.70	0.055	18.39	0.67	63.74	4.67	11.39	1.14	11812	11316

*Under the heading "Condition of Sample." "A. R."=As received, and "A. D."=Air dried.

LOCATION OF SAMPLES OF COAL IN TABLE.

Analyses
Nos.

1. Oak Forest Coal Company, Scott district, Putnam county, three miles from Winfield.
2. Oak Forest Coal Company, Scott district, Putnam county, three miles from Winfield.
3. Domestic mine, operated by William Porter, near Ashton, Hannan district, Mason county. Mrs. E. J. Herford, owner of land.
4. Domestic mine, operated by William Porter, near Ashton, Hannan district, Mason county. Mrs. E. J. Herford, owner of land.
5. Big Hrriucane Coal Company, Teays Valley district, Putnam county, on south side of Kanawha river, opposite Rumer.
6. Big Hurricane Coal Company. Teays Valley district, Putnam county, on south side of Kanawha river, opposite Rumer.
7. W. J. Keester, Hannan district, Mason county, Mercer's Bottom.
8. W. J. Keester, Hannan district, Mason county, Mercer's Bottom.
9. Hartford Coal and Mining Company, Waggener district, Mason county, Hartford.
10. Hartford Coal and Mining Company, Waggener district, Mason county, Hartford.
11. Liverpool Salt and Coal Company, Waggener district, Mason county, Hartford.
12. Liverpool Salt and Coal Company, Waggener district, Mason county, Hartford.
13. Harris Coal Company, Spillman, Waggener district Mason county.
14. Harris Coal Company, Spillman, Waggener district, Mason county.
15. Hutchinson Coal Company, Linden Mine Waggener district, Mason county, Hartford.

16. Hutchinson Coal Company, Linden Mine, Waggoner district, Mason county, Hartford.
17. James Holley Mine, near Jones, Teays Valley district, Putnam county.
18. James Holley Mine, near Jones, Teays Valley district, Putnam county.
19. Rankin Hill, Arbuckle district, Mason county, on Three Mile creek, three miles southeast of Point Pleasant.
20. Rankin Hill, Arbuckle district, Mason county, on Three Mile creek, three miles northeast of Point Pleasant.
21. Everett Hodges, near Jones, Teays Valley district, Putnam county.
22. Everett Hodges, near Jones, Teays Valley district, Putnam county.
23. Otto Marmet Coal Mining Company, Raymond City, Pocatalico district, Putnam county.
24. Otto Marmet Coal Mining Company, Raymond City, Pocatalico district, Putnam county.
25. Black Betsey Coal Mining Company, Black Betsey, Pocatalico district, Putnam county.
26. Black Betsey Coal Mining Company, Black Betsey, Pocatalico district, Putnam county.
27. Plymouth Coal Mining Company, Plymouth, Pocatalico district, Putnam county.
28. Plymouth Coal Mining Company, Plymouth, Pocatalico district, Putnam county.
29. Alpha Coal Mining Company, Plymouth, Pocatalico district, Putnam county.
30. Alpha Coal Mining Company, Plymouth, Pocatalico district, Putnam county.
31. Black Betsey Coal Mining Company, Black slate, Pocatalico district, Putnam county.
32. Black Betsey Coal Mining Company, Black slate, Pocatalico district, Putnam county.

CHAPTER X.

CLAYS, ROAD MATERIAL, BUILDING STONE, IRON ORE AND SALT INDUSTRY.

THE CLAY AND CLAY INDUSTRY IN JACKSON, MASON AND PUTNAM COUNTIES.

Professor G. P. Grimsley in Volume III of the State Geological Survey gives a report and general review of the clay industry in West Virginia, together with a discussion of the origin, physical and chemical properties of clays, their classification and uses.

In the area under discussion there are no outcropping deposits of fine fire clay, and no pottery industries. At Spilman in Mason county is located a brick plant and Professor Grimsley gives the following decription of same.

Spilman, Mason County.

"**Camden Clay Company.**—The plant of this company is located at Spilman, eight miles north of Point Pleasant on the Ohio river branch of the Baltimore & Ohio Railroad. The plant was erected in 1897 and its equipment includes a Williams patent pulverizer, 9-foot Boyd dry pan, 6-foot wet pan used for tile, pug mill, Chambers auger machine of 40,000 brick capacity, two double mold Eagle represses, 28,000 brick capacity each, a four mold, Chisholm, Boyd, White dry press of 24,000 brick capacity, and a Murray tile machine with capacity 8,000 shingle tile daily, which is not in use at the present time.

"The brick are dried in a hot air drier with six double track tunnels with a capacity of 40,000 brick. There are ten down-draft kilns with eight fire holes each, 28 feet in diameter, and holding 45,000 to 48,000 brick. Coal fuel is used and four

kilns draw into one stack which is partitioned. The paving blocks are burned from 11 to 14 days, and weigh before burning $12\frac{1}{2}$ pounds, and after burning $9\frac{1}{4}$ pounds; in size they average $9\frac{1}{4}$x4-$\frac{1}{8}$x3-$\frac{3}{8}$ inches.

"While the company makes a specialty of paving blocks, they manufacture some building brick and occasionally dry pressed brick. They formerly made roofing tile shingles, but this work has not been carried on for the past four seasons. The brick are red in color, very hard, and stand high tests of crushing, absorption, and rattler.

"**Shale Pit.**—The company formerly made red building brick and tile from a deposit of river clay near the works. The present shale pit was opened in 1901 and is located on top of the high hill just east of the plant. It is reached by a 1,500 foot incline, and is 260 feet above the brick plant. The shale is mined in open quarry, 28 feet high, and hauled in cars to the edge of the hill, where it is dumped into the long inclined chute and passed down to the crusher at the plant. The shales are much crumpled in places and the blue shale is filled with small lime nodules. The section of the hill is as follows:

	Ft.	In.		
Soil and clay cover	2	0		
Shaly sandstone	3	0		
Sandstone, buff	6	0		
Shales, buff or yellow (worked)	9	0		
Limestone nodules	0	8		
Shales, blue	6	0		
Shales, sandy and concealed	27	0		
Sandstone	4	0		
Sandstone, shaly	9	0	230′	0″
Red shales and clay	25	0		
Sandstone, shaly and clay	30	0		
Red shales	7	0		
Coal blossom, faint				
Limestone, irregular	3	0		
Shales, sandstone and concealed	80	0		
Sandstone, Pittsburgh	15			
Shales, finely laminated	10	0		
Coal, Pittsburgh	6	0		
Sandy shales and concealed to level brick plant	60	0		

"Comparing this section with the one at Hartford, six miles northeast, as given in Volume II of the reports of this Survey, page 142, the horizon of the shales worked at this

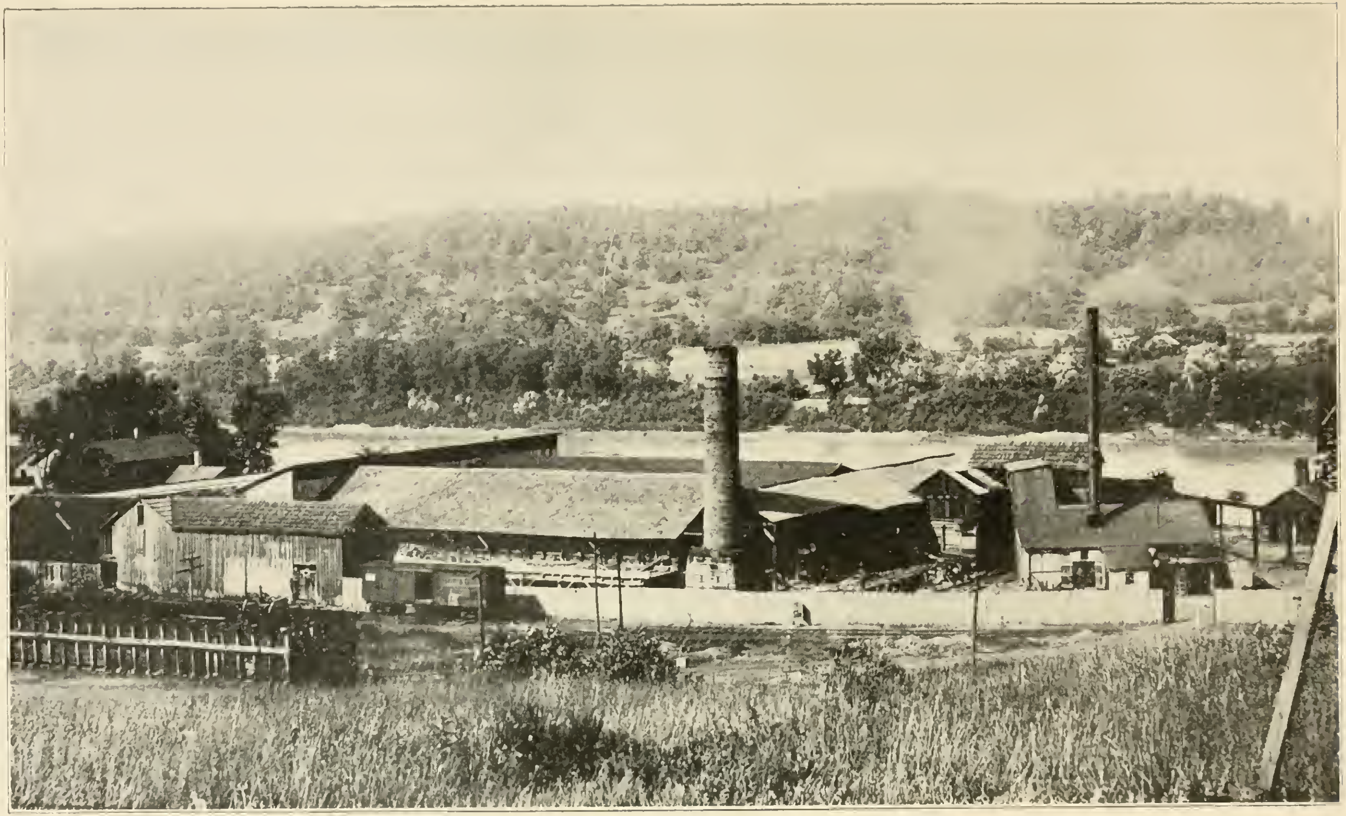


PLATE XXIX—Salt Works at Hartford, Mason County.

plant would be about 50 feet below the Waynesburg coal, which is the top member of the Monongahela series. The shales have never been given any special name, but may be called the **Spilman shales,** as this is the only locality where they are used.

"**Chemical Analysis.**—The average mixture of the blue and buff shales in this shale pit, and the buff shale, show the following composition:

	Mixture.	Buff Shale.
Silica	50.80	55.29
Alumina	19.47	21.87
Ferric iron	8.83	5.07
Ferrous iron	1.90	1.69
Magnesium	1.74	2.19
Lime	1.51	1.76
Sodium	.89	.55
Potassium	2.24	2.24
Water	.60	1.76
Titanium	.68	1.02
Phosphorus	.20	.60
Loss on ignition	11.37	6.34
	100.23	99.38

"**Physical Properties.**—The buff shale requires 29 per cent of water to develop a normal molding consistency, its maximum plasticity is 11, air shrinkage is 4½ per cent. The tensile strength is 83 pounds, or when weathered 152 pounds. The shale is not affected at cone 05 (1922°F.), but begins to vitrify at cone 1 (2102°F), and is completely vitrified at cone 5 (2246°F), with a fire shrinkage of 12 per cent."

The outcropping shales and old terrace deposits along the Kanawha and Ohio rivers and their tributaries in each of the three counties furnish good material for the manufacture of common building brick. These terrace clays are nearly always sandy and are adapted only to the manufacture of building bricks.

The following is a description of a brick plant located at Point Pleasant, Mason county, given by Professor Grimsley in Volume III, West Virginia Geological Survey, pages 266-267:

Point Pleasant, Mason County.

"**Mountain State Brick and Tile Works.**—This plant was started in 1896 by the present owner, C. L. Hess, just above the town. The equipment includes a Freese crusher and auger of 40,000 capacity, and 28,000 brick are made a day. The brick are dried in open sheds holding 90,000, and the Scott car system of filling and unloading the sheds is used. There are two up-draft kilns of 300,000 brick capacity each, and a down-draft kiln, which holds 75,000 brick or 50,000 drain tile. The tile are made from 2½ to 12 inches in diameter, and both brick and tile are of good red color. They are used for local use, and shipped to other points along the Kanawha and Michigan railroad.

"The clay is a river clay with sand pockets in it and covers probably 40 acres in this section and has a depth in the pit now worked of 13 feet. A similar clay was worked across the Kanawha river by Major James Smith for drain tile from before the war until 1893. Faite machinery was used and the works are still standing.

"**Chemical Analysis.**—The following analyses were made of the river clay used at the Hess yard, and of the shale (not used) on the hill above near the Baltimore & Ohio station:

	Hess Clay.	Shale.
Silica	65.97	56.48
Alumina	16.61	21.77
Ferric iron	4.84	4.78
Ferrous iron	.42	2.61
Magnesium	.53	2.10
Lime	trace	.72
Sodium	.63	.46
Potassium	2.17	3.00
Water	2.04	1.72
Titanium	.78	.83
Phosphorus	.06	.04
Loss on ignition	5.60	6.00
	99.65	100.51

"When the analysis of this river clay is compared with those farther up the Kanawha at Milton and Charleston, it is found to agree very closely.

"**Physical Properties.**—The Hess clay slakes in one-half

minute and requires 32 per cent of water to develop a normal molding consistency. The maximum plasticity is 14. The tensile strength is 183 pounds with a maximum of 205. This clay has a red color, but is not affected at cone 05 (1922°F.). Incipient vitrification begins at cone 1 (2102°F.), and is complete at cone 5 (2246°F.), with a fire shrinkage of 8 per cent.

Ravenswood, Jackson County.

"**Keller Brick Yard** is located at the east end of town and was started in 1899. About 12,000 brick are made a day, and burn red in color. The equipment consists of a Freese auger machine of 30,000 capacity with combined pug mill. There are two up-draft kilns, ten and fifteen arches, holding 125,000 and 240,000 brick which are burned with wood and coal. The river clay is worked to a depth of 15 feet and is reddish in color, streaked with blue."

ROAD MATERIAL.

The areas of Jackson-Mason and Putnam counties contain very little limestone, so it will be necessary to look to other material than limestone for road building material.

Considerable attention has been given to road building in the past two years by the State, and the roads have been greatly improved, but there is much yet to do to get them in first class condition.

The Nineveh Limestone.

As has already been stated in this volume, this limestone caps the highest hills in the northern part of Jackson county, but it is possible that this limestone contains too much impurity for road material as it easily disintegrates.

Gravel Pits.

Probably the best road building material within the area is the gravel in the terraces along the Ohio and Kanawha

rivers and their tributaries, and the gravel and hard materials found in the beds of the creeks and small streams.

This material consists of coarse and small boulders and gravel and after it is thoroughly tamped and packed in the roads makes fairly good road metal.

BUILDING STONE.

Prof. Grimsley gives a discussion of the building stones of West Virginia in Volume IV. of the West Virginia Geological Survey with an account of their origin, physical and chemical properties, and their uses.

The following sandstones of the Dunkard series outcrop in the Jackson, Mason and Putnam area:

Dunkard Series.

Gilmore	sandstone	(Description given on pages 101-102)					
Nineveh	"	(Description	given	on	page	103)	
Burton	"	(	"	"	"	"	104)
Fish Creek	"	(	"	"	"	"	105)
Rush Run	"	(	"	"	"	"	106)
Jollytown	"	(	"	"	"	"	107)
Hundred	"	(	"	"	"	"	109)
Upper Marietta	"	(	"	"	"	"	110)
Lower Marietta	"	(	"	"	"	"	114)

IRON ORE.

This area contains some iron ore in the red shales of the Dunkard series. Throughout Putnam county, quite frequently large nodules of iron ore are found in the red shales (Creston Reds) overlying the Lower Marietta sandstone and at one place in Buffalo district, on the waters of Eighteen Mile creek considerable money was spent in 1872, when Henry Pike and others of New York City built a tramway from Robertsburg southeast to the headwaters of Luke's Branch and Bear Branch of Eighteen Mile creek, a distance of five miles, and began to open up some iron ore. They

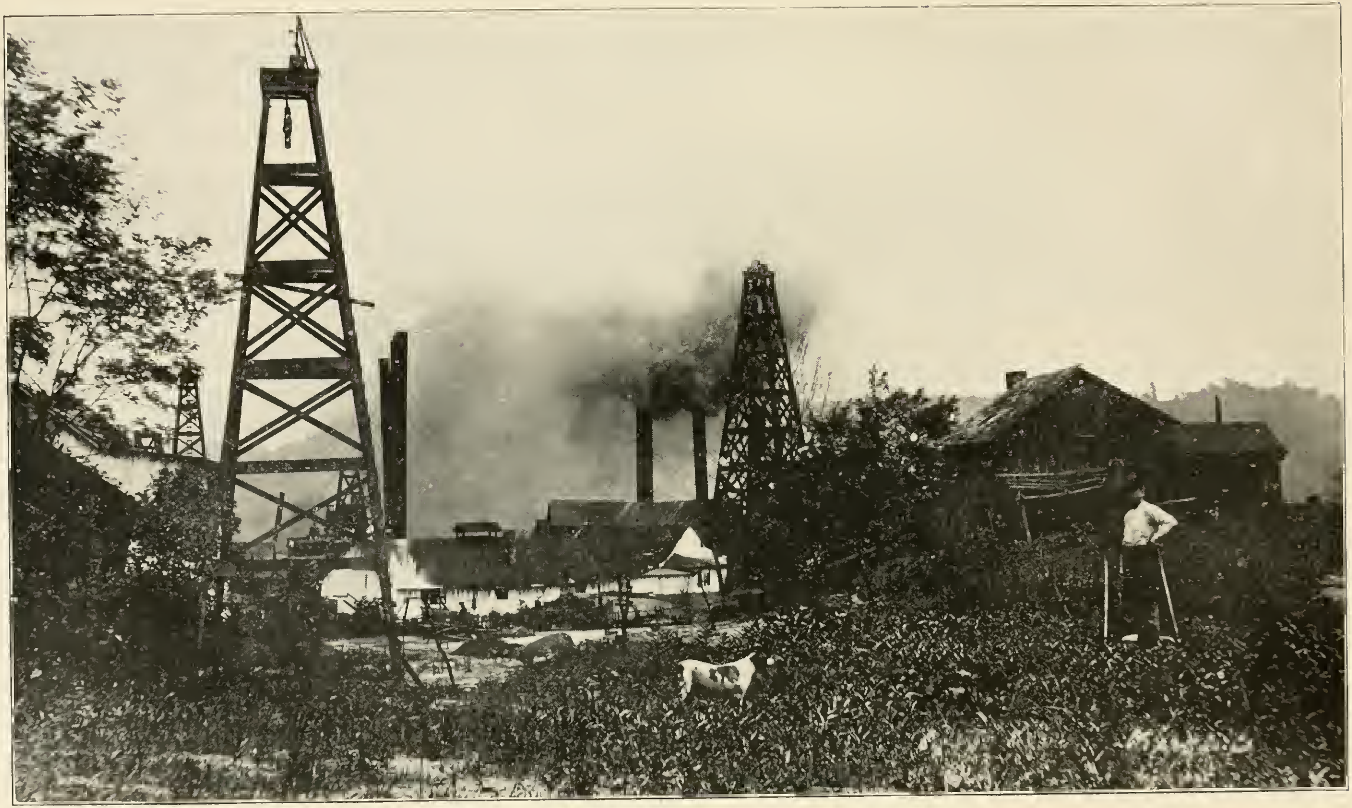


PLATE XXX—Salt Wells at Hartford, Mason County.

tested some of the ore, but never made any shipments, no doubt owing to the fact that this ore was not of sufficient thickness to warrant mining on a commercial scale.

Iron ore has also been mined in Jackson county on Log Lick branch of Mill creek, two miles southeast from Cottageville. This ore is located in the red shales overlying the Lower Marietta sandstone. In 1878-79 some parties from Bellaire, Ohio, opened this and shipped about four boat loads of ore from Cottageville. Evidently the ore was not of sufficient thickness or good enough in quality to work on a commercial basis and the mine was discontinued.

THE SALT INDUSTRY.

Salt making was one of the earliest industries in West Virginia. The first salt well was put down on the Great Kanawha river about six miles above Charleston to a depth of from 70 to 80 feet where a weak brine was found. Later the wells were drilled to a depth of 350 feet, and still later, much deeper.

Possibly the first salt manufactured in the Kanawha Valley was made by the Indians long before the whites had advanced so far westward. The first white person to assist in the manufacture of salt was Mrs. Mary Ingles, a captive taken by the Indians from her home in Virginia and brought through the Kanawha Valley, about 1753. The Kanawha Valley district was the first to manufacture salt west of the Alleghenies; later the development reached Mason county near Hartford City on the Ohio river.

Dr. J. P. Hale in his Report of Resources of West Virginia in 1876, gives the following on pages 275-277:

"In 1849 Messrs. Williams and Stevens, aided by Capt. Tom Friend, all Kanawha salt makers, bored for salt water at West Columbia in Mason county, on the Ohio river. They succeeded at about 700 feet in getting a fine well of water of good strength and at once proceeded to erect the first salt furnace on the Ohio river; they also bored several other wells in the vicinity, none of which, however, proved so good as the first. They shortly after sold the property to New York

parties who remodeled and rebuilt the furnace on a much larger scale, giving it a productive capacity of some 1,200 bushels, or more per day. The success of this enterprise gave a great impetus to salt boring, and coal mining throughout the available coal frontage of this region. This developed coal frontage along the river extends from West Columbia to Hartford City about 7 miles. Up the river the coal dips, until it passes under water level at, or just above, Hartford City.

"The second salt furnace was erected at this upper limit of the coal frontage in 1854 by a Hartford City (Conn.) company, then under the management of W. O. Healy, Esq.; since, and now under the management of G. W. Moredock, Esq., who has three large furnaces, with abundance of good brine, and cheap and convenient coal. These two operations, one at the extreme upper limit of the coal frontage, demonstrated pretty clearly the existence of good brines throughout that extent, and at once gave a value to furnace sites and coal lands which the owners had not hitherto suspected them to possess.

"In 1855 Mr. R. C. Lovell, another Kanawha salt manufacturer, bored wells and erected a large furnace about half way between the two points above named, and laid out a town which he called "Mason City." This valuable salt and coal property was afterwards purchased by L. H. Sargeant of Cincinnati, Ohio, and more recently has passed into the hands of Messrs. Roots and Kilbreth of the same city.

"Following these three furnaces, and within the next few years, were built the New Castle Burnup, Clifton, Bedford, Hope, German, Jackson, Valley City, Starr and New Haven City, in all thirteen in number. These thirteen furnaces have a present productive capacity of over 3,000,000 bushels per year.

"The usual depth to which the wells in this neighborhood are bored is about 1,100 to 1,200 feet; the strength of brines, 8 to 10; the quantity, 15 to 50 gallons per minute per well. The wells are tubed with iron tubing, usually about 4 inches internal diameter, and bagged at 600 to 800 feet depth, at which depth the pumps were worked, run by steam power.

"The coal used here in the manufacture of salt, and also

shipped to a considerable extent to the lower markets, is, geologically, the same as the well known Pittsburgh seam, so extensively mined and shipped near the city of that name. It is here a fine seam of coal, 4½ to 5 feet thick, easily mined, accessible and cheap.

"From the natural advantages of this locality, salt is produced here very cheaply, and cheaply freighted to the markets of the west, where it is in ready demand and its reputation deservedly excellent. From the bitterns or waste liquors from the salt furnaces here, a considerable quantity of bromine is manufactured, the uses and demand for which are steadily increasing. Chloride of calcium is also manufactured to some extent from these waste, bitter waters.

"The following table, kindly furnished by G. W. Moredock, Esq., of Hartford City, the largest manufacturer in Mason county, gives a very clear understanding of the present status of the salt manufacture in that county:

Salt Works, Mason County, West Virginia.

Name of Furnace.	Cap'city. Bushels.	Depth Wells. Feet.	Owner's Name.
New Haven	300,000	1,200	Hartford City Coal & Salt
Hartford City	300,000	1,150-60	Co., 1,100 acres of coal
Star	325,000	1,150-60	land.
Valley City	350,000	1,125-35	Valley City Coal & Salt Co.
Jackson	200,000	1,120-30	V. B. Horton, Jr.
German	250,000	1,120-30	German Salt Co.
Hope	350,000	1,120-30	Hope Salt Co.
Mason City	325,000	1,120-30	Mason City Salt Co.
Bedford	300,000	1,150	Bedford Salt Co.
Clifton	300,000	1,150	Not running.
Burnup or Quaker City	150,000	1,150	Not running.
New Castle	250,000	1,155	Not running.
West Columbia	300,000	1,125-40	Not running.
Actual capacity	3,700,000		
Actually made in 1875	2,500,000		

"It takes one bushel of coal to make a bushel of salt. Strength of brine from wells at Hartford City, 9 to 10, measured by Baume's salometèr; saturated brine 25, making the brine stand 40 per cent salt. (G. W. Moredock)."

The only important salt plants in West Virginia besides

those located on the Kanawha river near Malden, are the salt works in Mason City and Hartford.

Professor Grimsley in Volume IV of the West Virginia Geological Survey, pages 333-338, gives the following description of same:

MASON CITY AND HARTFORD CITY SALT WORKS.

Dixie Salt Company.

"The only plant now in operation at Mason City is the Dixie Salt Company, formerly the Mason-Hope Salt Company, whose plant was built thirty-five years ago by the Hope Salt Company. This plant was shut down three or four years ago and was in very poor condition, but in the Spring of 1907 was overhauled and partially rebuilt by a new company under the above name.

"The wells are 1,250 feet deep with the brine found at 1,100 to 1,150 feet, and they are pumped by sucker rods from the depth of 600 to 800 feet, into the storage tank. The brine with a gravity of 8° B., or specific gravity 1.056 corresponding to 8.2 per cent salt, flows from the storage tank to the furnace. The furnace pans are in four sections, of which the first three contain ten pans each, bolted together and 8 feet long, 3 feet wide, while the fourth section is a single open pan 30 feet long and 8 feet wide. Over all these pans is the steam box made of plant similar to the Malden plant.

"The heated brine is conveyed from the furnace pans through a wooden pipe to the first mud settler and then through the second and third, similar in construction and operation to the Malden plant, and from these passes into two draw settlers. The long vats are heated by the low pressure steam from the furnace steam box, conveyed through wooden log pipes to 4-inch copper pipes in the vats. The brine is drawn from the draw settlers into five salt grainers, 80 feet long, 10 feet wide, and lined with clay tiles. The mother liquor is drawn into a sixth grainer forming the bittern vat, and from this with the bromine and lime chloride goes to the bittern tank.

"**By-Products.** The bromine plant is similar in construction to the other plants and is housed in a small shed separated from the main plant. It contains one furnace and two stone stills. The liquor with the calcium chloride is taken across the river to the Pomeroy plant for further treatment. The daily capacity of this salt works is 200 barrels of salt, and 200 pounds of bromide.

"**Fuel.** The fuel used is coal secured from the company's own mine back of the town, and brought down a long incline track to a coal storage shed above the level of the railroad. From this shed the lump coal is loaded in railroad cars for shipment, while the slack and poorer coal are used at the furnace. The coal mined is the Pittsburgh seam, 4 to 5 feet thick, with the following composition, according to the Survey analysis:

Fixed carbon	45.93	per cent.
Volatile matter	39.25	" "
Moisture	1.87	" "
Ash	12.95	" "
	100.00	" "
Sulphur	1.95	" "
Phosphorus	0.013	" "

"One bushel of coal is said to make one bushel of salt at this plant.

"**Geology.** The wells were all drilled many years ago, and the works have changed ownership, so that if any records of the wells were ever preserved, they have been lost.

"Across the river at Pomeroy, Professor Bownocker gives the following record of a well drilled by the Buckeye Salt Company, where the top of the well is 25 feet below the Pittsburgh or Pomeroy coal seam:

	Top. Feet.	Bottom. Feet.
Conductor		58
Shale	58	550
White and gray sand	550	870
White sand and slate	870	960
Big Salt sand	960	1130
Sand and white shale	1130	1495
Berea grit	1545	1570
Total depth		1590

He states that brines were reported as follows:

Depth in Feet.	Density.
320	6° B.
710	9° B.
980	9° B.
1550	16° B.

"The brine in the Berea was much denser than that from the Big Salt sand, but it was small in quantity.

"**Chemical Composition.** Professor J. A. Bownocker in the report above quoted (P-27), gives the following analysis of the Pomeroy brine from the Coal Ridge Salt Works:

	Grains per liter of brine.	Grains per U. S. gals. of brine.
Silica	0.012	0.70
Iron and aluminum oxides	0.083	4.81
Calcium chloride	14.340	831.72
Magnesium chloride	5.590	324.22
Magnesium bromide	0.155	8.99
Strontium chloride	0.257	14.91
Barium chloride	0.343	19.89
Sodium chloride	84.300	4889.40
Sodium iodide	0.004	0.23
Sodium sulphate	0.000	0.00
Potassium chloride	0.114	6.61
Lithium	trace	trace
Specific gravity	1.075	

"An analysis of the salt made from this brine is also given by Professor Bownocker:

Moisture	7.42
Sodium chloride	91.31
Sodium sulphate	0.00
Calcium chloride	0.95
Magnesium chloride	0.32
Silica, iron, alumina	0.00

Hartford City Salt Company.

"Hartford City is located three miles above Mason City on the Ohio river. The plant of the Hartford City Salt Company is located at the upper end of the town between the railroad and the river, and was formerly known as the Valley City Salt Company. The brine is pumped from five wells drilled to the Big Salt sand of the Pottsville series into the storage tanks located on the hills above the plant and flows from these by gravity into the furnace pans where it is heated.

From these it passes with a gravity of 12° to 16° B. into two mud settlers and then into two draw settlers, 145 feet long and 12 feet wide. From the draw settlers it is carried into six grainers, 126 feet long, 12 feet wide, equipped with automatic salt rakers which push the salt forward at a rate of 4½ feet a minute, discharging it on a conveyor belt which carries the salt to the storage house.

"**By-Products.** The residual brine from the last grainer is drawn into the bittern vat and concentrated to 36° B., yielding a small quantity of agricultural salt. The bittern is then heated in the bromine pan, and the bromine extracted in two stone stills which are 7 feet thick with a 5-foot opening on the interior and made of Buena Vista sandstone. The liquor after removal of the bromine is run into a tank where the acid is neutralized by lime and has a gravity of 47° to 50° B. It is then boiled in the three calcium kettles heated by steam, until the calcium forms a thick syrup which is run into the sheet iron cans where it hardens in one to three days.

"The daily capacity of the plant is 250 barrels of salt, 125 pounds of bromine, or an average of one-half pound to the barrel of salt, and 5 to 6 tons of calcium or about 10 pounds to the bushel of salt.

"**Fuel.** The Pittsburgh coal, 4½ to 4 feet thick, mined in the hill back of the plant, is used for fuel. The composition of this coal is shown by the following analyses, one furnished by the company, and the other made by the Survey for the coal report (Volume II):

	Company.	Survey.
Fixed carbon	51	49.91
Volatile matter	39	39.79
Moisture	2	2.80
Ash	8	7.50
	100	100.00
Sulphur	1	2.02
Phosphorus		0.017

"**Chemical Composition.** Mr. C. D. Howard gives the following analysis of the Hartford City brine taken in March, 1904, but does not state from which one of the two plants the sample was taken:

	Parts in 1,000 parts by weight.	
Sodium chloride	74.191	
Potassium chloride	0.415	
Lithium chloride	0.0093	
Ammonium chloride	0.130	
Barium chloride	0.341	=21.33 grains per gal.
Calcium and strontium chloride	12.554	
Magnesium chloride	5.438	
Calcium bicarbonate	0.171	
Iron oxide and alumina	0.048	
	93.2973	
Specific gravity at 15.5° C	1.0732	

"Mr. Howard states that a special search for the elements, calcium and rubidium, in this example resulted negatively.

Liverpool Salt and Coal Company.

"The plant of the Liverpool Salt Company is located at the lower edge of the town of Hartford and to the south of the railroad track. A view of this plant is shown in Plate X, and Plate XI gives an interior view of the grainers and salt.

"The process of manufacture of salt from brine at this plant is similar to that at Malden, described above. Tubular boilers 72 inches in diameter and 18 feet long are used for production of high pressure steam for use in the evaporation of the brine in the grainers.

"The wells are 1,100 to 1,200 feet deep with 600 feet of brine in them. The daily capacity of the plant is 350 to 400 barrels of salt, 175 to 200 pounds of bromine, and 1¼ to 2 tons of calcium. The Pittsburgh coal is used as fuel.

"**Geology.** The wells secure their brine from the Salt sand of the Pottsville series. The following record of one of the more recent wells, furnished by Mr. H. F. Smith, the general manager, shows the character of the formations, the top of the well being about level with the Pittsburgh coal:

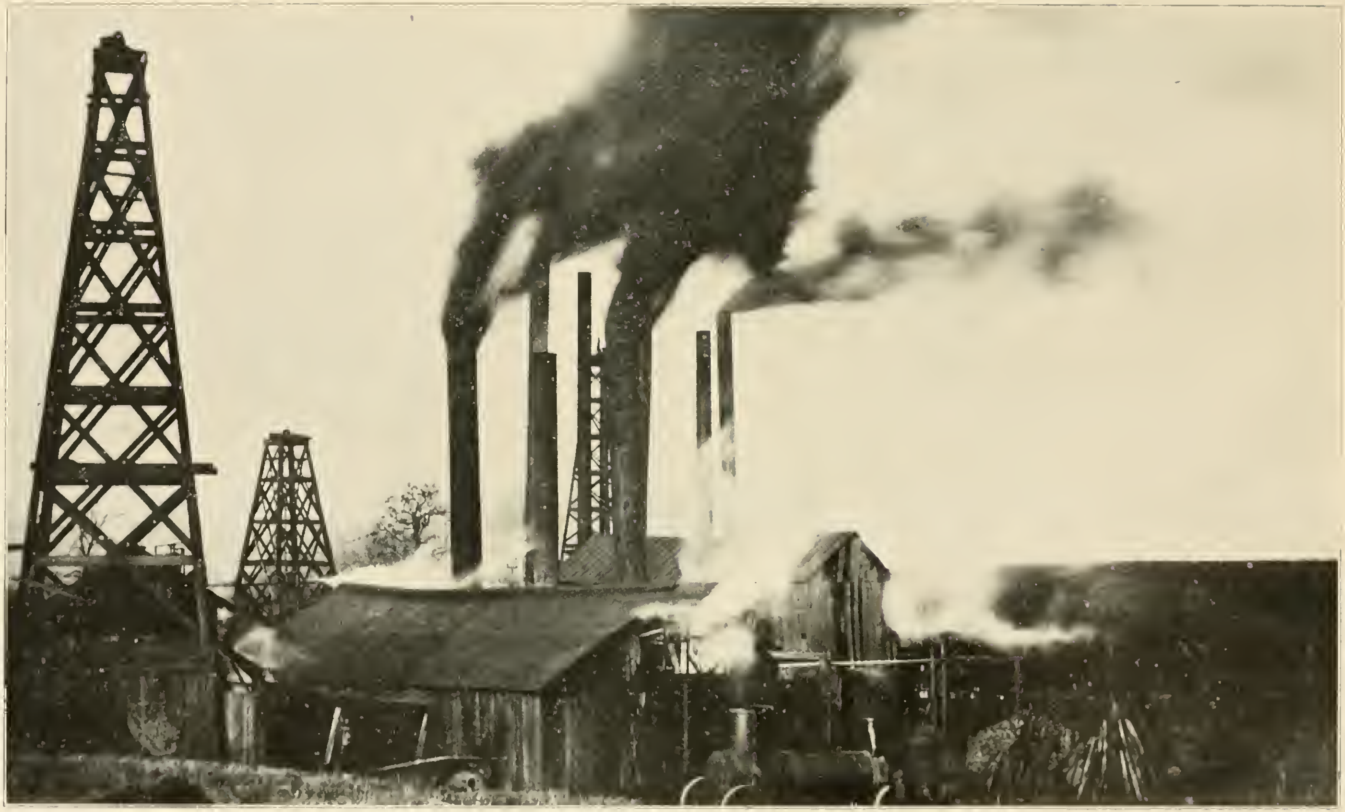


PLATE XXXI—Liverpool Salt Works, Hartford, Mason County.

	Feet.	
Drift and unrecorded	300	
Horseneck sand	50	
Shales	110	
First Cow Run sand	40	
Shales	250	
Second Cow Run sand	40	
Shales	210	
First Salt sand	50	
Shales	55	
Second Salt sand	60	(used for brine)
Total depth	1165	

CHAPTER XI.

DESCRIPTION AND HISTORY OF THE TIMBER IN THE JACKSON-MASON-PUTNAM AREA.

Mr. A. B. Brooks, Forester, in Volume V of the West Virginia Geological Survey, has published a description of the timber conditions in the different counties of the State.

He gives the following interesting description of Jackson county on page 162:

"Jackson county once had an immense amount of fine white oak, yellow pine, yellow poplar, chestnut, black walnut, red oak, black oak, chestnut oak, beech and hickory, with smaller amounts of white elm, sugar maple, red maple, basswood, white ash, sycamore, white walnut, hemlock, white pine, black gum and others usually found with them. Yellow pine grew on sandy hills and south exposures in nearly all parts of the county, but more abundantly toward the northeast.

The Lumber Industry.

"By the year 1830 there was a store and blacksmith shop at Ripley, the present county seat, and several settlements had been made along the Ohio river and at other places inland. It is hardly necessary to mention that here, as elsewhere, some of the best timber was destroyed by the early settlers who needed the use of the land more than they needed the timber. The small amount of lumber used in the construction of rude dwellings and outbuildings was sawed by hand or on upright or sash saw mills run by water power. As early as 1835 there were five combination grist and sash saw mills on Mill creek and probably others on Sandy creek. These sawed for domestic use and some lumber from them was rafted to the Ohio river and there sold to dealers.

"Extensive floating has been carried on along Mill creek, Sandy creek, and Pocatalico river. Logs floated by private owners and by companies were caught in booms at the mouths of the three streams named above. Here they were rafted and taken to Cincinnati and other cities along the Ohio river. Cole and Crane of Cincinnati, were the principal rafters and took out an enormous quantity of poplar, oak and yellow pine from about 1880 to 1897. According to Mr. B. F. Armstrong, of Ripley, steam saw mills were brought to the interior of the county about the year 1870. At least one steam saw mill was in operation in the river valley in 1847. Between 1870 and the completion of the Ripley branch of the Baltimore & Ohio Railroad in 1888 the steam saw milling consisted largely in the cutting of cross-ties. These were floated on the creeks and caught in the booms at their mouths. After the extension of the branch railroads up Mill creek to Ripley at the date given above, and up Sandy creek four years later, many portable saw mills were put in operation and the lumber manufactured by them shipped from Ripley, Evans, and other stations. The several saw mills now in operation saw cross-ties and a little lumber in the winter and thresh grain in the summer and fall. No band mills have operated at any time in the county.

"The cross-tie industry has been extensive for twenty years, and many were cut before that time. About 75,000 ties were cut in the county in 1909. In 1908, 150,000 were cut, and not fewer than half a million went out during some single years preceding this.

"Much of the good white oak was manufactured into split, bucked and sawed staves. The staves were floated or hauled to the Ohio river and there were sold to the coopers of Parkersburg and other cities. It is stated that as many as seventy-five teams could often be seen in a day hauling staves on the Ravenswood road. The staves were hauled from far in the interior and frequently two or three days were required to make the trip. Merchants frequently bought staves and shingles, paying for them with goods or cash."

The following is a description given by A. B. Brooks, Forester, in Volume V, pages 193-197, of the West Virginia Geological Survey, concerning the timber in Mason county:

"The tree growth in the rich valleys of the two large rivers of the county, and the growth of all manner of plant life' was exceedingly luxuriant. According to Mr. John McCulloch of Point Pleasant, grape vines ofter grew to such enormous size that some of them were split into rails for fencing; and the poplars, oaks, black walnuts, wild cherries, hickories, and many others attained a size that was rarely reached in other parts of the State. The remarkable growth of timber in this region attracted the attention of early explorers. Christopher Gist, who was sent out from Virginia as an exploring agent of the Ohio Company, visited the Mason county area in 1751 and again in 1752. Under date of February 24, 1751,—while encamped in the Ohio river valley, some miles above the mouth of the Great Kanawha—this explorer made the following entry in his journal: "The bottoms about 1½ miles wide full of lofty timber." On February 20, 1752, he speaks of the Great Kanawha bottoms near the mouth of Thirteen Mile creek, as "fine land" and as being "very rich." Again on February 23rd, he refers to the Ohio river valley, a few miles above Point Pleasant, as "fine rich land, the bottoms about a mile wide." It will be understood that the expressions "very rich," and the like, carried with them the idea of good timber, for in the days of extensive forests, the trees furnished the best indication of the fertility of the soil.

"On the 30th day of October, 1770, George Washington and party were at Letart Falls, on the Ohio river. He describes the appearance of the country as follows:

" 'We landed, and after getting a little distance from the river, we came, without resting, to a pretty lively kind of land, grown up with hickory and oak of different kinds, intermingled with walnut.'

" 'On October 31st,' he says: 'I sent the canoe down about five miles, to the junction of the two rivers, that is, the Kanawha with the Ohio, and set out with a hunting party to view the land.' * * * Two days later the party encamped on the Great Kanawha river at the mouth of Sixteen Mile creek. 'At this place,' he wrote: 'Some of our people went up the river four or five miles higher. * * * As you approach the hills, you come to a thin, white oak land, and poor. The

hills, as far as we could judge, were from half a mile to a mile from the river, poor and steep in the parts we saw, with pine growing on them.'

"On November 3rd, he says: 'We set off down the river, on our return homeward, and encamped at the mouth. At the beginning of the bottom, above the junction of the rivers, and at the mouth of the branch of the east side, I marked two maples, an elm, and a hoop-wood tree, as a corner of soldiers' land, if we can get it, intending to take all the bottom from hence to the rapids in the Great Bend in one survey. I also marked at the mouth of another run, lower down the west side, and at the lower end of the long bottom, an ash and hoop-wood tree, for the beginning of another of the soldiers' surveys, to extend up so as to include all the bottom in a body on the west side. In coming from our last encampment up the Kanawha river, I endeavored to take the courses and distances of the river by my pocket compass, and by guessing.' November 4th: 'Just as we came to the hills, we met with a sycamore about sixty yards from the river, of a most extraordinary size; it measuring 3 feet from the ground, 45 feet around, lacking 2 inches; and not fifty yards from it was another, 31 feet around.' November 5th: 'The growth in most places, beach intermixed with walnut, but more especially with poplar, of which there are numbers very large. The land toward the upper end is a black oak and very good.' * * *

"Ten different kinds of trees are referred to in the above quotations from Washington's journal, and the two distinct types of land—the rich valley and the poor hill land,—are described according to the forest growth that each produced.

"In answer to an inquiry concerning original timber conditions, etc., in Mason county, Hon. Virgil A. Lewis, State Historion and Archivist, gives the following interesting account:

"I remember something of the forest conditions in Mason county fifty years ago, that is to say, about the beginning of the Civil War. The entire county was a remarkable forest region. At that time there were "clearings" or "improvements" throughout all the hill country. Along the two rivers,

Ohio and Great Kanawha, the county has a frontage of 92 miles; and it may be said that there are about 92 square miles of level bottom land. This was then, as now, the chief agricultural region of the county; but there were still magnificent forest preserves belonging to large estates along both rivers. Over them grew gigantic poplars, walnuts, and wild cherries, with lofty hickories and with oaks of various kinds, including the famed Spanish oak, some of which were five feet in diameter. Over the whole region were forests of square miles in extent which had scarcely been reached by the woodsman's axe. Here grew the sugar maples in dense groves, and the spring of the year was the happy sugar-making time when thousands of pounds of maple sugar were made and shipped to various points. In the early days many hundreds of bird's eye poplars (then called "cat-faced poplars") were felled and rolled into the streams to be floated away or put in heaps and burned in the "clearings" then being opened. Many of the finest trees were used in the building of "worm fences." The ordinary "rail cut" from which the rails were split was usually 11 feet in length. Oak and poplar, and even walnut trees were used for this purpose. I yet remember how readily the walnut "cuts" split and how many hundreds of panels of fence were built of this valuable wood.

"'I have no doubt, if the present value of lumber should be placed upon the timber burned in the "clearings" in Mason county, on the hills, along the streams and on the bottom, from the coming of the first white man in 1774 down to the year 1860, that it would aggregate many millions of dollars.'

"A two-story house once built near the present town of Ashton was constructed, almost entirely of walnut logs. The house was in a remarkably good state of preservation when it burned a few years ago.

The Lumber Industry.

"The destruction of timber by early settlers is mentioned in the foregoing paragraphs. During the period when the forests were being opened there were here and there the old water power saw mills, which manufactured lumber for floor-

ing in the log houses. About the year 1860 the water power was replaced by steam power and a large number of mills—still using the upright saws—were put in operation in the hill sections. This now became a leading industry in the years im mediately after the war. Circular saw mills were introduced soon after this and remained until the timber was practically exhausted. Most of the mills were small. At Point Pleasant and some other places, however, there were larger operations. Comstock's mill operated at Point Pleasant in the '60s. This was succeeded by Benedict's mill, and this by Sehon's mill, the last to manufacture in quantities for shipment.

"Much of the timber floated on the Ohio and Great Kanawha rivers was manufactured on local stationary mills. Considerable good oak was rafted to Cincinnati and Louisville for shipbuilding purposes, and some was used about the year 1860 by shipbuilders from Maine in the manufacture at Point Pleasant of several coasting vessels.

"The present lumber industry consists of the work of two or three small portable saw mills, a planing mill or two, and the boat works at Point Pleasant."

Present Forest Conditions.

"Perhaps the largest good tract of timber remaining in the county is on the Steenbergen farm near Point Pleasant. The tract contains 200 acres of practically virgin hardwood. A few farmers in different parts of the county have reserved and protected small boundaries of fairly good timber. In nearly all cases, however, the woodlots contain only a remnant of the original stand."

The following is given by A. B. Brooks, Forester, on pages 254-256 in Volume V of the West Virginia Geological Survey in regard to Putnam county:

Original Timber Conditions.

"The timbers of the county were principally hardwoods, the oaks, yellow poplar and beech predominating. The principal softwoods were yellow pine and red cedar. There were

small quantities of white and scrub pine and hemlock. Mr. Louis Brandhart of Winfield, gives the names of forty hardwoods that are commonly found in this section, and speaks of oak, yellow poplar and yellow pine as timbers that deserve special mention on account of their abundance and good quality. A yellow poplar, said to have been 10 feet in diameter and 80 feet to the first limb, once stood in the southern end of the county.

The Lumber Industry.

"Much of the rich bottom land and portions of the hill country were cleared by the early settlers many years before the timber had any commercial value. Only a small percentage of the heavy stand of timber could be utilized for log houses, fences, etc., and so the rest was rolled together in heaps and burned, just as it was in all other pioneer settlements. The only lumber manufactured during these early times was sawed by hand operated whip saws or by primitive water saw mills. The latter, however, were not used to a great extent as in many other counties. Ventroux mill, which ran many years ago on Hurricane creek, was of this type.

"About the first timber cut for commercial purposes was split into barrel and pipe staves by the owners of wood land and sold for cash or traded for goods at the various stores located at Buffalo, Red House, Winfield, Poca, and other points along the river. The merchants shipped most of the staves down the river in barges. This industry began before the Civil War and continued for ten or fifteen years. Later this grew into a large business. Buyers came in and bought and shipped staves from all points along the river and in many sections in the interior. Staves that were bought in the hilly sections were often floated down the creeks and runs and were loaded with those from the valley in barges at the river. Most of the staves were sold to Poston Stave Company. Stewart, Morrison & Company, and other coopers, made a large number of salt barrels at Winfield, Poca and other places, during the days when the Kanawha river salt furnaces were flourishing.

"An extensive sawed stave industry was carried on by D. G. Courtney of Charleston, approximately from 1885 to 1900, with mills at Raymond City. Large quantities of oak growing on Pocatalico river and its tributaries were manufactured by him into oil barrel, firkin, tub and beer keg staves, and shipped to Holland, Austria and other European countries. He also manufactured lumber and cross-ties during the same period.

"The cutting of cross-ties and hoop-poles began early and continued for many years. Merchants bought cross-ties, just as they did staves, and shipped them in barges or by rail. This practice is still kept up to some extent.

"Much oak and poplar was cut and taken out in the log for ship timber between 1870 and 1900. Hanley Brothers were the chief purchasers of logs for this purpose.

"The rafting of logs to Huntington, Ironton, Cincinnati and other points was an important feature of the lumber industry for many years. Black walnut was taken out, principally in the log on the river and by rail.

"Portable saw mills have been operating in the county for forty years or more and have had a large share in the reduction of the timber stand in all sections. Much of the oak was sawed into export and car stock, the later going principally to the car works in Huntington.

Merchants bought and shipped considerable tan bark twenty-five years ago and some was bought by other purchasers. A quantity of bark was sold also to a company which loaded it on a boat provided with machinery for grinding and pressing it into cakes of a convenient size and shape for shipment.

"A few portable mills are still operating irregularly, some of which manufacture cross-ties and others lumber.

"Two or three farmers along the river are keeping up groves of red cedar which produce profitable yields of excellent posts.

Present Forest Conditions.

"Not far from half of the county is still wooded, but there is but little good timber remaining. A few farmers have reserved small boundaries of good timber. Most of them, however, have disposed of even their young trees for cross-ties.

"Farmers own all the forest land in the county except a broken tract of 24,000 acres lying above Winfield, and fronting on the Great Kanawha river; a tract of 10,000 acres owned by Whitehouse heirs, who have leased same to coal companies; and about 2,200 acres owned by a coal company on the south side of the river two miles from Winfield. Scattered improvements are found in many parts of the forest tracts mentioned above, and an area of only about 4,500 acres, lying northeast of Winfield can properly be classed as cut-over forest land."

CHAPTER XII.

SOIL SURVEY AND MAPS OF THE POINT PLEASANT AREA.

In co-operation with the Soil Survey of the United States Department of Agriculture, Dr. Milton Whitney, Director, the State Geological Survey secures the soil experts of that department to study, classify and map the several kinds of soil found in each county of the State. This information is especially valuable to the agricultural and horticultural interests of the State, since the chief characteristics of each class of soil are fully described, and the uses to which it is readily adapted, as well as suggestions for increasing its fertility. The accompanying soil map of the counties of Jackson, Mason and Putnam, to be found in the case of maps, together with the following soil report and description of the area by Messrs. Latimer and Mooney, the soil experts of the United States Department of Agriculture, cannot fail to prove of great benefit to the farming interests of the district:

SOIL SURVEY OF THE POINT PLEASANT AREA, WEST VIRGINIA.

By W. J. Latimer and Charles N. Mooney.

Description of the Area.

The Point Pleasant area lies in the southwestern part of West Virginia, along the Ohio river. It comprises the counties of Mason, Jackson, and Putnam, and has a total area of 814,910 acres or 1,274.86 square miles. The area is bounded on the north by the Ohio river and Wood county; on the east by Wirt, Roane and Kanawha counties; and on the south by

Kanawha, Lincoln and Cabell counties; and on the west by Cabell county and the Ohio river. The area contains more navigable river front than any other area so far surveyed in the State of West Virginia and consequently contains a larger percentage of bottom land.

The upland portion of the area is the remains of an ancient plateau of the Appalachian Province that has been cut by the channels of large streams and modified by erosion and the cutting of deep V-shaped valleys by small streams. The topography of the upland is very broken for the most part and consists of narrow "hog-back" ridges and steep hillsides. However, in many places the ridges broaden out into small plateaus and in others the hills are more rounded, and the sides more gently sloping. In the western part of Mason county the ridge tops are fairly flat and the valleys deep and decidedly V-shaped. Rocky promontories are frequently found along the bluffs of the larger streams. The upland for the most part is well suited to grazing and the flat ridge tops can be cultivated without danger of erosion.

The bottoms upon the larger streams, including second bottom, vary from one-fourth to one mile in width. The Kanawha bottoms average about one mile in width throughout the area. Upon many of the small streams the bottom land is very narrow and in many places entirely wanting. A very marked topographic feature of the area is the ancient stream channels and subsequent deposits, represented by Teays Valley and the many winding channels of the ancient Ohio river found in the northern part of Mason county.

The lowest point in the area, where the Ohio river crosses the Mason-Cabell county line, is about 500 feet above sea level and the highest point—Garnes Knob, in Jackson county—is about 1,300 feet above sea level, giving a range of 800 feet in elevation. The general line of the ridge tops is from 800 to 1,000 feet above sea level with many places reaching above 1,200 feet. The general elevation of the ridges above the streams is about 200 to 400 feet. The ridges dividing the drainage systems are very irregular in shape and serrated in relief, although the general level of the highest points seems

to be in the same plane. This is also noticeable in many of the spurs.

Most of the drainage of the area goes through small streams directly to the Ohio river. The remainder goes into the Kanawha river and thence to the Ohio river. Practically all the secondary drainage ways head within the area.

Many early explorations were made into the area; the most notable of these was by the French, who placed a disk at the confluence of the Ohio and Kanawha rivers, laying claim to the country. But it was not until the summer of 1770 when George Washington and his corps of engineers made a survey of many large tracts of land along the Ohio and Kanawha rivers that any actual steps were taken toward the colonization of the country. These tracts were granted to soldiers of Virginia for their services in the French and Indian wars, and about 20,000 acres were patented by Washington, mostly within the limits of this area. Washington made many offers to induce imigration, but the remoteness of the country and the danger from Indians prevented settlers from coming. Not until after the battle of Point Pleasant, October, 1774, was it safe for settlers, and then only in the immediate vicinity of the fort. A settlement was made at Point Pleasant after the battle by some of the pioneers that participated in the fight.

Washington abandoned his scheme of colonization during the War of Independence, and it was not until after that struggle was over that any attempt was made to settle the outlying districts.

The State of Virginia established a land office in 1779 and offered land for 2½ cents an acre (continental money). Large tracts of this land were bought by eastern speculators, but no settlers took up the proposition until after the peace of 1783.

The first settlement was made in Teays Valley in 1800. Buffalo, the oldest town in Putnam county, was laid out in 1834 and incorporated in 1837. Winfield was not incorporated until 1868; however, a settlement was made at Red House Shoals in 1806 and a ferry established in 1815. Settlements were made in Jackson county along the Ohio river in 1796. The first cabin was built in Ravenswood in 1808. The early

settlers came in boats down the Ohio river from Pennsylvania, Maryland and Virginia, and down the Kanawha river from Virginia and the Carolinas. They were largely Scotch-Irish and English, and from necessity and environment were hunters and trappers regardless of their previous vocation. The remoteness of the country and the difficulty of transportation from the manufacturing centers reduced the imports to bare necessities. Small patches were cultivated to furnish bread and vegetables for home use, while game and fish supplied the meats. Nearly all fabrics of wearing apparel and household goods were manufactured at home.

The pioneers settled the bottom land along the large streams first and gradually worked back into the hill country. During the early occupation of the country the hill land was considered worthless and settlers stopped where they pleased, built a cabin and made a clearing. Many of the settlers of this class were afterward turned out by holders of patents for service in the Revolution.

Mason county was formed in 1804 from Kanawha county; Jackson in 1831 from Mason, Kanawha and Wood counties; and Putnam was formed in 1848 from Mason, Kanawha and Cabell.

The following table gives the growth of population in the several counties as shown by the United States Census:

Population of Counties Included in Point Pleasant Area.

Counties.	1850	1860	1870	1880	1890	1900	1910
Mason	7,539	9,173	15,978	22,293	22,863	24,142	23,019
Jackson	6,544	8,306	10,300	16,312	19,021	22,987	20,956
Putnam	5,335	6,301	7,794	11,375	14,342	17,330	18,587

The building of the turnpikes was an important factor in the early development of the area. The most important of these was the James River and Kanawha turnpike from Richmond, Virginia, to Huntington, West Virginia, passing through Teays Valley. This was begun in 1778 and completed to Huntington in 1830. The Charleston and Point Pleasant turnpikes, extending along both sides of the Kanawha river, were completed in 1851 and 1861 respectively. The Parkersburg and Charleston pike, crossing Jackson in a general north

and south direction, was completed in 1861. The Ravenswood and Spencer turnpike and the Ripley and Spencer turnpike were completed in 1854 and 1858, respectively.

The factors influencing the later development of the area were the opening of the railroads and the locking and damming of the Kanawha and Ohio rivers. The Chesapeake & Ohio Railroad was opened to traffic to Huntington in 1872 and was the most important of all the railroads built in the area, giving direct connection to the east. The Kanawha & Michigan Railroad was opened from Charleston to Point Pleasant in 1882. The Ohio river division of the Baltimore & Ohio Railroad was completed in 1884; the Ripley branch in 1888, and the Spencer branch in 1892.

The improvements upon the Kanawha river were started in 1875 and there is now a complete lock system from Charleston to Point Pleasant. The lock and dam system upon the Ohio river, which is to give a 9-foot stage the year round from Pittsburgh to Cincinnati, is still in progress of construction and will be a great benefit to the area when completed.

Salt is made in the area from brines, and was first shipped from the Kanawha district in 1808. The works here were subsequently abandoned. The Hartford City salt district extends along the Ohio river from Hartford to West Columbia, a distance of about seven miles. The first salt well drilled in this district was at West Columbia in 1849. In 1880 the production was 2,500,000 bushels and in 1908, nine furnaces turned out 3,700,000 bushels of salt. The salt produced is of a very high quality and many chemicals are produced as by-products. The salt is obtained from the sands of the Pottsville series, the wells being from 1,100 to 1,200 feet deep.

The oil industry is not developed in this area as in many of the adjoining counties. But much of the land in the south and eastern part of both Jackson and Putnam counties is under lease and some producing wells have been obtained.

Coal was discovered at Raymond City in 1800, but it was not until about 1860 that mining operations were commenced. The mine has been in operation since that time. A number of mines are located along the Kanawha river. Coal is mined along the Ohio river from Hartford to West Columbia and

also at Ashland. The first mines in this district were opened in 1845.

Nearly all of the present population of the area is descended from the original settlers and is largely agricultural or engaged in business that is mainly dependent upon agriculture. Very few people of foreign birth are found. There are a few negroes, mostly in Point Pleasant and Teays Valley. The stream valleys are the most thickly populated parts of the area, especially the high terraces along the larger streams. The flat ridge tops and limestone ridges are fairly well populated. Nearly all the area is cleared and largely in pasture.

Point Pleasant, the largest town in the area, has a population of 2,045 (1910 Census). The town is situated at the junction of the Ohio and Kanawha rivers, and is the center of the boating and docking business of the Kanawha river and a long section of the Ohio river. The Kanawha & Michigan Railroad and Baltimore & Ohio Railroad (Ohio river division) cross at the point and give ample railroad facilities and cheap rates. Also water transportation facilities favor the city as a manufacturing point. Mason City is an important town on the Ohio river opposite Pomeroy, Ohio. Hartford and New Haven are small towns in the same district. Ravenswood, the largest town in Jackson county, population 1,080 in 1910, is situated upon a high terrace of the Ohio river and is the junction of the Spencer and Ravenswood branch of the Baltimore & Ohio Railroad. It is the center of the Jackson county apple district and has a canning factory and creamery. Ripley, the county seat, is the distributing point for a large part of Jackson county and a large cattle market. Millwood is a small town but an important fruit market, and Leroy is a small town upon the Ravenswood and Spencer branch of the Baltimore & Ohio Railroad and the center of the Jackson-Wood-Wirt tobacco district. Winfield, on the Kanawha river, is the county seat of Putnam county. Raymond City is a mining town also upon the Kanawha river. Hurricane, in Teays Valley, lies in a prosperous farming section and is the center of the Teays Valley tobacco industry.

The area is supplied with excellent transportation facili-

ties. The Ohio and Kanawha rivers give water transportation to important markets. The latter is navigable practically the year round and the Ohio river will be navigable for the entire year when the system of locks and dams, now under construction, is completed. The Chesapeake & Ohio Railroad crosses the southern end of the area through Teays Valley. The Kanawha & Michigan Railroad passes through the area along the north side of the Kanawha river, crossing the Ohio river at Point Pleasant. The Ohio river division of the Baltimore & Ohio Railroad extends the length of the area along the Ohio river. The system has two branch lines, one traversing the northern end of Jackson county and the other reaching to the center of the county at Ripley. The public road system is good, considering the topography of the county, and the character of soils and road material. The county is threaded by telephone lines and nearly all farm houses are supplied with telephone and daily mail service.

The principal market for cattle, sheep, hogs, veal, turkeys, chickens, eggs and fruit is Pittsburgh. Some cattle and wool go to Baltimore and Philadelphia. Parkersburg and Wheeling also furnish small markets for farm products. Local markets such as Gallipolis, Pomeroy and Middleport, Ohio, use a quantity of vegetables and dairy products. Charleston and Huntington also afford good markets for truck and dairy products.

Climate.

The climate of the Point Pleasant area is healthful and agreeable. There are no long continued spells of excessive hot weather and the cold spells are not especially severe and are generally of short duration. The annual mean temperature is 56° F., the absolute minimum is 26° F. below zero, and the absolute maximum is 102° F. But the temperature rarely falls below zero or rises above 100° F. Hence, the summers are warm, but not exceedingly hot, and the winters are cold but not rigorous. January and February have an average mean temperature of 32.5° F.; July and August an average mean temperature of 76°F.

The alternate freezing and thawing common to the sec-

tion during early spring is very beneficial to the soil, loosening it up and putting it in good physical condition.

The precipitation, about 40 inches, is well distributed throughout the year, the heaviest rainfall occurring during the growing season, June and July, and the lightest in September and October during the harvest season. The snowfall is light and remains upon the ground only a short time. The active growing season has a duration of six months, but pasture can be used eight months in the year.

The climatic conditions in this area make it well suited to agriculture, to the carrying on of either general farming, stock raising, dairying, fruit culture, or late trucking.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau Station at Point Pleasant:

Normal Monthly, Seasonal, and Annual Temperature and Precipitation at Point Pleasant, West Virginia.

Month.	Temperature. Mean.	Absolute Maximum.	Absolute Minimum.	Precipitation. Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December ..	35	70	— 5	3.1	4.4	2.6	1.6
January ...	33	73	—14	3.6	1.5	8.0	4.9
February ..	32	75	—26	3.6	1.3	1.9	5.0
Winter ..	33	....	....	10.3	7.2	12.5	11.5
March	45	84	4	3.7	2.4	5.8	5.0
April	55	95	23	3.0	6.9	1.5	0.5
May	66	98	31	3.5	5.8	3.5	0.0
Spring ..	56	....	....	10.2	15.1	10.8	5.5
June	73	102	44	4.8	7.3	2.4	0.0
July	77	102	47	3.7	0.7	2.8	0.0
August	75	99	50	3.2	1.6	6.4	0.0
Summer .	75	....	....	11.7	9.6	11.6	0.0
September .	70	100	37	2.2	2.3	2.1	0.0
October ...	58	90	19	1.9	0.2	3.2	0.0
November .	45	81	14	3.2	2.6	2.7	0.5
Fall	58	....	....	7.3	5.1	8.0	0.5
Year	56	102	—26	39.5	37.0	42.9	17.5

Average date of last killing frost in spring, April 17; of first in autumn, October 18.

Agriculture.

As already stated, the early settlers paid little attention to agriculture, clearing only small patches and planting such crops as wheat, corn, flax, and potatoes for home consumption.

At the next stage in development the staple crops were grown and sold to emigrants on their way west. This became quite a profitable business. Before the days of steamboats or railroads, the farmers along the Ohio and Kanawha rivers shipped potatoes, wheat (as flour), and apples by flat boat to New Orleans.

The growing of wheat became quite an industry after the establishing of water power mills, and continued so until the opening of the western wheat fields by the railroads. The farmers of this section could not compete with the virgin lands of the west, as machinery for handling large crops could not be used successfully upon the hill land. The recent high prices of wheat have again stimulated the growing of that crop on a considerable area. The production of oats seems to vary in inverse proportion to that of wheat, but oats have never been an important crop. Corn has been grown in larger quantities than any other crop since the first settling of the country, and has shown a steady increase in each decade. The hay crop is of considerable importance and the production has steadily increased, although the country is considered a grazing rather than a hay producing country. White clover grows wild in this section and bluegrass comes in naturally on all cleared ground where weeds are kept down, but the natural growth cannot be depended upon for a stand.

Tobacco was produced in large quantities from 1850 until a few years after the Civil War, its culture being discontinued when the war tax was placed upon it. About 1880 the growing of tobacco began again. From 1890 to 1900 a slump in prices caused a proportionate curtailing of the acreage. During the last few years production has increased at a rapid pace, owing to the sharp advance in price caused by the pooling of the crop in Kentucky. The varieties grown are White and Yellow Burley, used largely for plug tobacco. The greater part of the crop is air cured, under which method expensive equipment is not required.

The growing of tobacco up to a few years ago was confined to the limestone ridges in the northern part of Jackson county and to Teays Valley in Putnam county. But recently the crop has spread to such an extent that in the southern part of Mason and Putnam counties it is grown even on bottom lands. It is estimated that the production for 1909 is about 25 per cent greater than for the preceding year. The production of the Jackson-Wood-Wirt tobacco district will probably reach about 2,500,000 pounds. Over three-fourths of this is grown in Jackson county. About 3,000,000 pounds were handled through the Hurricane market last season from the Teays Valley district. The tobacco grown upon the limestone ridges is of good quality and the growers have learned to handle the leaf successfully.

The old river terrace soils produce a very fine leaf which is used mostly for plug wrappers. The bottom land, while giving heavy yields, produces a dark inferior grade of tobacco.

A large area is in bluegrass pastures and a considerable area is in mowing, mainly timothy and clover. Hay is usually stacked and fed to stock in the field. Cowpea hay is produced to a limited extent. The early Black pea is considered the best variety for hay production and the Whippoorwill for seed. Soy beans and vetch do well, but are used less than cowpeas. Sorghum is grown in small patches in all parts of the area, both for syrup and forage. Broom corn is grown upon the bottom land in some sections. Millet is grown to a very limited extent. Buckwheat is used as a cover crop to some extent, but the most of it is harvested.

Irish potatoes are produced in large quantities upon the high terrace land along the Ohio river and to a lesser extent in nearly every part of the area. The larger growers spray with Bordeaux mixture and Paris green. Sweet potatoes are grown to a considerable extent upon the sandier types and phases of the bottoms and terraces.

A much smaller acreage is devoted to rye and barley than in former years. Some patches of alfalfa are occasionally seen on the Brooke clay loam, but the results have been indifferent. The poor results are probably due to improper preparation of the seed bed and failures to provide proper inoculation.

Cantaloupes and watermelons yield abundantly upon the light terrace soils of the Ohio river. A considerable acreage is devoted to tomatoes, particularly in bottom lands near Ravenswood. Vegetables are grown in all parts of the area for home consumption and local markets, but very little is shipped out of the area. The canning factory at Ravenswood uses large quantities of tomatoes and corn.

Fruit growing as an industry is well developed in certain sections of the area, along the low hills and terraces of the Ohio and Great Kanawha rivers. Many commercial orchards are found that are kept in good condition by spraying, pruning, etc.

The apple is the important fruit. The Ben Davis, Imported Ben Davis, Rome Beauty, York Imperial, Baldwin, Northern Spy, Grimes Golden, October Rambler, and Russet are the leading varieties. The Ben Davis is grown more extensively than all the other varieties combined. The Rome Beauty and York Imperial are the next important varieties in commercial orchards. The other varieties are found mostly in small mixed orchards.

Bordeaux and Arsenical mixtures are in common use for combatting orchard pests. In the last few years many orchards have been sprayed on contract for one-half the fruit.

Peaches are grown to some extent upon the limestone ridges and the old terraces. The Elberta does best. Late and Early Crawford are also considered good varieties. Cherries, plums, and grapes do well, but are only grown for local consumption. Small fruits such as blackberries, raspberries, and strawberries yield large crops of excellent fruit, but are grown only on a small scale.

Several nurseries producing mainly apples and shade trees are situated within the area, upon the Ohio river terraces near Point Pleasant and Mason City.

The following table gives the acreage and production of the principal crops, according to the census of 1910:

	Wheat.		Corn.		Oats.	
County.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
Mason	25,203	225,640	26,049	638,660	1,023	16,480
Jackson ...	19,775	163,990	26,919	605,290	1,224	16,560
Putnam ...	14,285	113,730	21,326	443,320	1,307	18,250
Total .	59,263	503,360	74,294	1,687,270	3,554	51,290

	Tobacco.		Clover.		Potatoes.	
County.	Acres.	Pounds.	Acres.	Tons.	Acres.	Bushels.
Mason	126	78,490	1,573	1,402	967	58,089
Jackson	325	215,310	1,584	1,226	1,113	59,292
Putnam	929	626,680	1,457	1,350	458	27,971
Total	1,380	920,480	4,614	3,978	2,538	145,352

	Cultivated grasses, including clover.		Vegetables.		Sorghum.	
County.	Acres.	Tons.	Acres.	Value.	Acres.	Gallons.
Mason	11,149	8,893	931	$ 47,898	238	16,558
Jackson	15,528	10,955	1,008	48,310	370	23,698
Putnam	6,541	5,787	944	55,339	283	19,082
Total	33,218	25,635	2,883	$151,546	891	59,338

	Sweet Potatoes.		Value of orchard	Value of forest	Value of small fruit	Value of dairy
County.	Acres.	Bushels.	products.	produces.	products.	products.
Mason ..	122	6,115	$ 38,004	$106,361	$ 5,058	$127,049
Jackson .	134	7,589	40,417	133,563	2,390	135,748
Putnam .	111	6,604	44,780	92,216	3,352	102,002
Total	367	20,308	$123,201	$332,140	$10,800	$364,799

The early settlers kept a few cattle, but it was not until 1840 that this industry became important. The first cattle were of common grades and up until the building of the railroads they were driven to the eastern markets. About twenty years ago attention began to be paid to the introduction of pure bred cattle. The Shorthorn was the first pure breed introduced. Blooded cattle were nearly all introduced from Roane county. The Hereford, strictly a beef type, was introduced about fifteen years ago, and the Aberdeen-Angus, another beef breed, was introduced near Ravenswood five years ago. The Hereford predominates at the present time, but there seems to be very little difference in the relative value of these two breeds. They are both well adapted to the conditions of the area and

give satisfactory results. Many large dairy herds are maintained along the Ohio and Kanawha river bottoms, the Jerseys and Holstein breeds predominating. Milk is shipped to Charleston, Huntington, Parkersburg, and local markets.

Some sheep were raised by the early settlers, but the industry did not become important until the '60s. It flourished until about 1890, when the low price of wool caused it to be almost abandoned. The first pure strains to be introduced were the Merinos near Garfield, followed by the Southdown and Shropshire. The last named breed was introduced about six years ago. The Southdown is the principal breed raised in the area now, as they seem to find the climatic conditions especially favorable to their nature. They are used for both wool and mutton. Sheep are very destructive to pasture sods and are kept mostly in the rougher sections of the area, and upon the limestone ridges where close grazing is not so severe on the grass. The sheep upon the limestone soils produce a very fine grade of wool and under ordinary circumstances only such "wool breeds" as Delinas and Merinos should be handled; but the present high price of mutton makes a dual purpose breed more profitable.

Goats are raised in small herds in the rougher sections of the area. They prove very efficient in keeping down noxious weeds and shrubbery in pastures. It pays to keep them only on very rough land where the grazing of cattle is impossible.

Hogs are raised in all parts of the area, but largely for home use and local markets. The Poland-China, Jersey-Red and Chester-White are the principal breeds.

The raising of chickens and turkeys constitutes an important industry which, however, is carried on mainly in a small way on many farms usually as an adjunct to general farming and stock raising. Considerable quantities of poultry and eggs are shipped. Horses are not raised in sufficient numbers to supply the local demand.

As the early settlers cleared the bottom land first and then moved back into the hill country, the section along the Ohio river was brought under cultivation first. Having been longer cultivated, this section, that is, the hilly uplands, has suffered most from erosion. The interior country coming into use

later has been more generally utilized for grazing, and consequently more land here has had the effective protection against erosion offered by sod. Too little attention, however, has been paid to the maintenance of grass, with the result that erosion has made no little headway. The limestone land and heavy calcareous soils such as the Brooke clay loam and Upshur clay have needed comparatively little attention, as such land is highly adapted to blue grass, but it is well even with such good grass land to keep down shrubbery and weeds and to reseed the area in which the grass occasionally plays out.

Many farmers take advantage of the alternate freezing and thawing of winter to prepare their heavy soils, plowing in January and February, preferably the latter part of February. The variable weather of spring assists in pulverizing the clods and bringing the soil into a good condition of tilth. If breaking is put off until spring, the unfavorable soggy condition of the soil makes it almost impossible to prepare the fields in time for the planting season. Upon the heavier soils deep plowing is usually practiced.

The agricultural methods differ widely in different sections of the survey. In the southern part of the area, where tobacco is becoming the principal crop, the tendency is toward a one crop system; while in the northern part of Jackson, where large quantities of tobacco are also grown, farming is more diversified. Over a large part of the area cattle raising is the principal industry and all other operations are subordinated to that. Along the low range of hills back from the Ohio and upon the old river terraces fruit growing receives a great deal of attention. Along the Ohio river bottoms diversified farming is practiced with trucking or dairying as a strong feature. The Kanawha river bottoms are extensively utilized for wheat and hay.

Labor saving and improved machinery such as cultivators, corn binders, and shredders are used mainly upon the valley land of the large streams.

In a general way the farmers of the Point Pleasant area recognize the adaptability of certain soils to certain crops, though crops are grown more or less indiscriminately on all classes of soils. Corn is the most important crop on the bot-

tom lands, and these are admirably suited to its production, but nearly every type in the area is used to a certain extent for corn. Tobacco does best on the heavy limestone lands and on some other freshly cleared soils or with fertilizers. It is also grown upon the bottom land, where the yields are heavy, but the leaf is rather inferior and the crop subject to total loss by overflow.

The Ohio river terrace soils are recognized as excellent potato, melon and truck soils, while the continuous red hill land is valued for its grazing qualities. The low flat ridge tops along the Ohio river (the remains of an ancient stream terrace) are recognized as good fruit land and the industry is here developed to some extent, but the full value of these soils for fruit is not appreciated. However, the adaption of soils to crops may be recognized in the hill country. To a certain extent the natural conditions compel some crops to be grown indiscriminately; still the important crop should be determined by the character of the soil.

Crop rotation is given most attention by the farmers of the Ohio river bottoms and second bottoms and those farms on the limestone ridges. Many farmers in other parts of the area follow a certain form of rotation, often unintentionally.

A rotation commonly practiced on the Ohio river bottoms and terraces is as follows: First year, corn with cowpeas or crimson clover; second year, corn, vetch or rye; third and fourth years, red clover and timothy. If the ground is poorly drained or sour, alsike clover is commonly sown. Where the soil is high and well drained, corn stubble is often sown to wheat and grass.

Rotations for getting land sodded for mowing are practiced as follows: On bottom land, corn two years, then red clover and timothy; on hillside land, corn one year, then red clover and timothy; on crests of hills and ridges, corn the first year, wheat the second year, oats the third year, and then clover and timothy. A rotation used in bringing new land into pasture is: corn followed by wheat with red top and blue grass. The red top is sown as a nurse crop for the blue grass. Orchard grass and white clover sometimes form part of the grass mixture.

In the tobacco districts a rotation used on new land is: First year, tobacco; second year, tobacco; third year, wheat and clover with blue grass if pasture is wanted and timothy if intended for hay. Very often the clover is turned under and the same rotation repeated.

The fertilizers most commonly used in the area are: Bone meal, acid phosphate, ground phosphate rock ("floats"), nitrogen-phosphate mixtures (often a 14 per cent phosphoric acid and 2 per cent nitrogen mixture) and commercial mixtures ranging usually from 8 to 10 per cent phosphoric acid, 1½ to 2½ per cent nitrogen, and from 4 to 8 per cent potash. Some lime is used on acid soils and in some cases upon grass. Bone meal, ground phosphate rock, acid phosphate and phosphate-nitrogen mixtures are used for wheat in quantities varying from 100 to 400 pounds per acre. Complete fertilizers are used for tobacco and truck crops. Basic slag gives good results with timothy. Bone meal and floats are good for any kind of sod. There are many farmers that do not use commercial fertilizers at all and many others that use them sparingly and indiscriminately. There is no question that they are profitable on certain soils; that is for some crops.

Manure is used to a great extent upon the terrace soils and uplands for corn. Stock is often fed upon the field from which the hay is cut, thus returning practically all that is taken off.

Very little nitrogenous fertilizer is used and the growing of leguminous crops is becoming more popular every year. Sorghum and cowpeas make a splendid mixture, the cowpeas at the same time improving the land.

The agricultural practices on the whole are fairly well suited to the conditions in the area.

Much of the efficient labor of the farms has been lured to adjoining counties by the opening of large oil fields. The wage paid in the oil field is about $2 a day for the same class of labor that commands $1.00 to $1.25 a day upon the farm and $1.50 and $1.75 upon public works. An average price paid for labor in the interior uplands is $20 to $25 a month, or 75 cents a day with board. Farm hands along the Ohio river receive from 25 to 50 cents more a day than in other parts of the area.

The labor as a rule is efficient but rather scarce. Much of the work is done by the farmer and his family. Laborers hired by the year are usually furnished houses, gardens and pasture.

The farms as a rule are small and most of them are operated by the owners. In the southern part of the area much of the tobacco is grown on rented land. One-half the crop is the usual rental on limestone soils, where owner furnishes team, tools and land, and the renter the seed and labor. Upon the bottom lands the owner furnishes land only and gets one-half the corn and hay. Rentals, however, are adjusted to suit the circumstances. Limestone land and river bottom land are not usually rented, especially where they are kept in a high state of cultivation.

Many suggestions can be made pointing to the improvement of the agriculture. In a country where such a large number of people are interested in stock raising, the maintenance of good blue grass sods is important. The use of sodium nitrate as a top dressing will often be found valuable in rejuvenating an unproductive sod. Stable manure can be and is used to a limited extent on grass, but it is not so quickly effective. Liming is beneficial to sod, but it should be done before the grass has too completely disappeared, in which case reseeding is the only remedy. Many of the steep hillsides should remain in forest, and it would be advantageous to plant some of the present steep pastures that show signs of washing in locust. If allowed to remain in pasture it is only a question of a short time before erosion will remove much of the surface material.

The use of legumes, such as cowpeas, soybeans and vetch, should be more general. These crops are used to some extent by the farmers along the Ohio river terraces, but are not in common use in the hill sections. By the use of legumes the cost of fertilizers is reduced to a minimum. Upon the hill land the keeping of as many live stock as a farm will support, about three head per acre of good grazing land, is strongly recommended. A good rotation to follow in continuous cropping is: First, corn; second, oats or wheat; third, clover, cutting first crop and turning under, follow with potatoes.

If orchards are situated upon a soil type that is well suited to sod, the maintenance of a strong sod grazed by hogs or sheep is recommended. But upon light soils cultivated methods of handling orchards is preferred, using vetch or clover for cover crops.

Soils.

Nineteen distinct types of soil are found in the Point Pleasant area. These types represent three different physiographic regions,—the uplands, terraces and flood plains.

On the base of differences in origin and certain physical characteristics the several types are grouped in nine series.

The several members of each series have the same general appearance and the same general physical properties, but each differs from the other in texture.

The following table gives the soil types as grouped according to topographic position and origin:

	Origin.	Soil Type.
Upland residual soils.	Limestone.	Brooke clay loam.
	Coarse-grained sandstone.	Dekalb sandy loam.
	Fine-grained sandstone, arenaceous shales and gray shales	Dekalb silt loam.
	Red calcareous shales.	Upshur clay.
	Red calcareous shales and gray shales	Upshur silty clay loam.
	Sandstone, arenaceaus shales, gray and red shales.	Meigs clay loam.
	Rock outcrop usually sandstone.	Rough stony land.
Stream terrace soils (second bottom old alluvium).	Ohio River	Wheeling silt loam. Wheeling fine sandy loam Wheeling fine sand. Wheeling sandy loam. Wheeling gravelly loam.
	Kanawha and small streams..	Tyler silt loam. Tyler silty clay loam.
	Ohio River high terraces and Teays Valley alluvium.......	Holston silt loam.
Flood plains (first bottoms, recent alluvium).	Ohio, Kanawha and other streams	Huntington loam. Huntington silt loam. Moshannon silt loam. Moshannon clay.

The soils of the upland vary from rough stony land (mainly rock outcrop and steep stony areas) to heavy clay, the immediate surface portion being predominately silty. These have been formed by the disintegration and decomposition of the rocks of the Dunkard, Monongahela and Conemaugh formations of the Upper Coal Measures, consisting of stratified thin recurrent beds of sandstone, arenaceous shales, soft red calcareous shales, yellow, gray and greenish shales, limestone, and to a very small extent, coal and bituminous shales. Of these formations, the sandstone, red shales and limestone are by far the most important, both in extent and influence upon the soils.

The sandstones occur in strata varying in thickness from 10 to 100 feet, with an average of about 20 to 40 feet, and are interbedded with the other formations, of which the red calcareous shales form the greater portion.

Where the last named rocks predominate, the resultant soil type is the Upshur clay. It is found largely developed where the Creston reds of the Lower Dunkard outcrop over the eastern and central part of Jackson county, northeastern Mason, and the western part of Putnam. A few developments of this formation are found south of the Great Kanawha river in Mason county. The Upshur clay found in other parts of the area usually occurs in small bodies and is derived from the thin and widely separated beds of red calcareous shales of the Upper Dunkard, Monongahela and Conemaugh formations. The Upshur clay is somewhat calcareous, but perhaps not as much so as the general run of the type to the north of the Point Pleasant area.

The Upshur silty clay loam has the same Indian red clay subsoil as that of the Upshur clay, but the surface soil averages more nearly gray in color.

The type occurs upon the low hills back from the Ohio river. The topography is not steep, and weathering has taken place to a considerable depth. The surface portion of this type resembles somewhat that of the old alluvial type, Tyler silt loam, but there is no such conclusive evidence that the material is of alluvial origin.

Where the red shales are less in evidence and the sand-

stones, arenaceous shales and gray shales are found, the weathered materials are more or less mixed and the soil is varied by patchy occurrences of different colored and to a lesser extent different textural types. This rather variable soil is mapped as Meigs clay loam, a type occurring in nearly all parts of the area, though most extensively developed in the southern part, where the Monongahela and Conemaugh formations form the main proportion of the outcrops. The Meigs clay loam of this area includes less Upshur clay than in the Parkersburg and Spencer areas to the north.

The weathering in place of the fine-grained sandstone, arenaceous shale, and gray shales give rise to Dekalb silt loam. It usually occurs in fairly level areas as the result of the weathering of massive strata of the first-named rock or is supported by such strata.

The Dekalb loamy sand is formed by the weathering in place of coarse-grained sandstones and is usually found upon ridgetops. It is developed to a comparatively small extent. The Dekalb soils in general are not naturally strong soils.

The Nineveh limestone, near the top of the Dunkard, the main limestone formation of the area, gives rise to the Brooke clay loam. This formation has a maximum thickness of about 50 feet, and though mainly pure limestone, includes several interbedded strata of shale. The resultant type is the strongest upland soil in the area and is much more extensively developed here than in the adjoining areas surveyed.

The outcropping of massive sandstone strata gives rise to rough stony land. Notable among these formations are the Waynesburg, Pittsburgh and Mahoning sandstones, the horizon of which make the base of the Dunkard, Monongahela and Conemaugh, respectively. Rough stony land is poorly developed in this area, and is of little importance.

The Sandyville syncline* has much to do with the distribution of the soil types. The line of this depression passes through the area in a general northeast and southwest direction, entering the area near Beatyville, passing through Sandyville and to the west of Ripley, near Baden, Leon and Upland. From the last place it passes south parallel to the

*See West Virginia Geological Survey, Point Pleasant Area Report.

Mason-Putnam county line. The rock strata rise slowly in both directions from the syncline and the axis of the syncline rises gradually to the southwest.

Erosion is very active upon the exposed hillsides of the upland soil types. The Upshur clay upon the hill country adjacent to the Ohio river has also suffered severely from wash. Clearing and cultivation in this section began with the early settlement of the county.

Land slides are frequent upon the steep hillsides on the Upshur clay and Meigs clay loam. They usually occur during the spring rainy season and are probably caused both by the giving away and the underlying rock strata loosened by frost and by the overloading of the soil by water. These slides sometimes represent simply a settling or slipping of the soil a few feet, but often on steep hillsides the material is moved for considerable distance, causing more or less mixing of the soil, especially where there is some original variation in the material, which is frequently the case, and also bringing about an uneven surface condition. Roads and fences are often displaced by these slides.

The terrace soils along the Ohio river, represented by the Wheeling soils, are largely composed of glacial material transported from the glacial regions to the north. Five types of this series are found; silt loam, fine sandy loam, sandy loam, fine sand and gravelly loam. This is the most valuable series of soils in the area. The silt loam occurs on the lowest of these second bottoms, the fine sandy loam about 10 to 20 feet higher, the sandy loam slightly higher, and the fine sand in the highest situations frequently lapping up on the lower slope of the uplands as an apron. This last type has had its surface markedly influenced by wind action. The gravelly loam is found either at the level of the sandy loam or is the exposed gravel bed below the Wheeling silt loam.

The terrace soils along the Great Kanawha river and other smaller streams (Tyler series) have the appearance of being derived more largely from Dekalb soils than from the red soils, like the Upshur, but the poor drainage condition to which they have been subjected has probably brought about changes in the material since deposition, assisting probably in

the development of the light color and rather unfavorable structural conditions. These soils are locally called "Crawfish land."

Teays Valley*, the ancient bed of the Kanawha river, consists of beds of gravel resting upon bed rock covered by a thin stratum of sand or laminated clays and surmounted by deep deposits of silt. The presence of laminated clay is evidence of lacustrine origin†. Where the silty mantle has been removed by erosion, the exposed clays have given rise to the Tyler silty clay loam.

The brown silt loam derived from the Teays Valley deposits has been classified as silt loam. In the older river channels and on some of the high, old terraces between Ravenswood and Point Pleasant back from the Ohio river, the soil is so similar to the Holston silt loam that it seems best to include it with this type.

These high terraces have suffered considerably from erosion, and in many places have been cut through to bed rock, leaving only a few small areas of the old alluvium. This erosion has been most active in case of the flat-topped ridges back from the Ohio river between Ravenswood and Mason City. The Holston silt loam here resembles the Dekalb silt loam in many respects, but is usually heavier and more productive.

The Ohio river bottoms proper, the Huntington soils, are all subject to overflow, but the highest of these, the Huntington loam, is inundated only by very high freshets. These are very valuable agricultural soils.

The high bottom land along the Great Kanawha river, represented by the Moshannon series, is subject to overflow once in about every four or five years. Much of the Moshannon has poor drainage owing to the numerous slight depressions. The Moshannon silt loam is a first bottom soil subject to overflow. It has a distinctive reddish brown to chocolate red or Indian red color, due to the abundance of material washed from the red upland soils as the Upshur clay. When this type has received much wash from limestone land, the

*See Charleston folio U. S. Geological Survey.

†See Charleston and Huntington folios U. S. Geological Survey.

Brooke clay loam, it seems to be more productive than elsewhere.

The bottom land soils are all fairly well drained, except, of course, when overflowed, and are very productive. Along the smaller streams they are more liable to overflow during the growing season than along the rivers. The bottom lands are best adapted to corn and grass and produce good yields each season without the aid of fertilizers.

Areas of Different Soils.

The following table gives the names and areas of the several soil types shown in the accompanying maps:

Soil.	Acres.	Pct.	Soil.	Acres.	Pct.
Meigs clay loam	419,264	51.7	Brooke clay loam	4,928	0.6
Upshur clay	145,856	18.0	Tyler silty clay loam	4,864	.6
Dekalb silt loam	74,752	9.2	Moshannon clay, Erosion phase	4,608	.5
Huntington silt loam	29,248	3.6	Huntington loam	4,480	.5
Holston silt loam	25,856	3.2	Wheeling fine sandy loam..	3,584	.4
Tyler silt loam	23,424	3.0	Wheeling fine sand.......	1,280	.2
Moshannon silt loam....	19,776	2.7	Wheeling sandy loam	1,152	.1
High lying phase	2,496		Wheeling gravely loam	768	.1
Upshur silty clay loam ..	20,288	2.5	Dekalb loamy sand	448	.1
Rough Stony land	15,296	1.9			
Wheeling silt loam	9,152	1.1	Total	811,520	

Upshur Clay.

The soil of the Upshur clay is a dark reddish brown or dark Indian red, heavy clay loam to clay about 5 inches deep. The subsoil is a plastic and tenacious heavy red clay, becoming more compact as depth increases. The surface cracks badly when dry, and deep fissures are found in sunbaked surfaces. Upon the hilltops the type is usually of the deep red or Indian red color, while the hillsides are more nearly of a brownish-red color. The hilltop phase represents the stronger of the two phases, for that upon the hillsides is very often mixed with light colored sandstone and shale soil. Most of the type occurs on the hillsides. It is not quite so heavy in this area as in the adjoining areas already mapped. Spots of Meigs clay loam, too small to map, are found occasionally scattered through the type.

In many places limestone fragments and concretions are found upon the surface and throughout the profile. In other places fragments of iron are found.

The Upshur clay is formed through the weathering in place of red and greenish colored calcareous shales of the Upper Carboniferous beds. The type is found largely developed in Jackson county, in the eastern part of Mason county, and the northern part of Putnam county. Typical developments occur upon the hillsides of the country adjoining the Ohio river and its tributaries in Jackson county. Where the Creston reds outcrop, the Upshur clay is the predominant soil type.

The calcareous shales from which the type is derived are soft and weather very rapidly and deep. The soil in other parts of the area are derived from other formations than the Creston reds, is not altogether typical, and occurs only in small detached spots.

The Upshur clay is a productive soil and supports a fine bluegrass sod. Wheat yields 10 to 25 bushels, corn 30 to 60 bushels, oats from 20 to 25 bushels and hay 1 to 2 tons per acre. Wheat is grown to some extent upon the ridge tops, but the oats acreage is very small. Tobacco is grown and gives fairly good yields upon new land. Clover and leguminous crops are not grown to any great extent.

The type is too heavy for potatoes and most vegetables. It is not especially adapted to apples, peaches or small fruits, although they are produced on a small scale for home consumption. The trees seem to be very subject to disease, and little success has been had in commercial orcharding.

The type is very difficult to cultivate, and erodes badly where exposed. For these reasons it should be mainly kept under sod, and every precaution taken to keep the sod in good condition. Liming and the application of manures and of nitrate of soda will be advisable for this purpose. The type furnishes good grazing land, and it is largely upon it that the cattle industry of the country has been developed.

Much care should be taken to plow this soil when in the right moisture condition. If plowed too wet it clods badly and serious injury to the soil results. Plowing should be done in the fall or in January or February, so that alternating freezing and thawing may pulverize the soil thoroughly. Spring plowing is all but impossible, owing to the cold damp nature

of the type. Manures, lime, legumes, and cover crops should be used to improve the physical condition. Commercial fertilizers in the form of bone meal or floats (ground phosphate) should be used with wheat, when preceding grasses. If wheat is to follow wheat or is to be followed by a cultivated crop, a more soluble form of phosphates should be used, as "acid phosphate."

Nearly all the type is cleared of its hardwood growth and most of it is in pasture. It is valued at $20 to $75 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type.

Mechanical Analyses of Upshur Clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24621,24623	Soil	2.3	3.8	2.1	5.4	12.3	41.4	32.4
24622,24624	Subsoil .	.0	.3	.6	4.4	1.9	32.4	60.4

Upshur Silt Clay Loam.

The soil of the Upshur silt loam* is a grayish brown to light red silty clay loam about 8 to 12 inches deep. The soil grades imperceptibly into the subsoil, which is a heavy red silty clay loam to silty clay to 24 inches, where it becomes a heavy plastic clay of Indian red color. The surface color over a large part of the type is not very different from that of the Dekalb silt loam, but the subsoil has a typical Upshur color.

The type is derived from red shales, with some fine grained sandstone. It occurs on the more gently sloping hillsides and rounded hilltops where weathering has taken place to a considerable depth. Very few fragments of shale and sandstone and no limestone fragments or concretions are found.

The type is developed mainly upon the sides of the low hills back from the Ohio river, between Ravenswood and New Haven and along Sandy and Mill creeks.

Typical developments occur north of Fairplains in Jackson county and in the vicinity of Board in Mason county.

*Small areas of this soil occur in the Parkersburg area, but owing to the small size they were included with the Dekalb silt loam.

In this area the type embraces a considerable extent, making it an important soil. It has a wide adaptation, combining the good qualities of a fruit and trucking soil with those of a general farming and grazing type.

It is a good fruit soil, especially for apples, and some splendid orchard sites are included in the type. It is an easy soil to cultivate, and, though not so strong as the Upshur clay, it produces good general farm crops, such as corn and wheat. It supports a strong bluegrass sod. The productive capacity of the type falls about half way between the Upshur clay and Dekalb silt loam.

The soil is usually deficient in organic matter, and this should be supplied by growing clover and cowpeas and by the turning under of cover crops.

Nearly all of the type is cleared and most of it is in pasture. But the proportion of its area under actual cultivation is much higher than in case of the Upshur clay. The original forest consists principally of oak, hickory, and walnut. Pine and locust form the second growth. Owing to the gently rolling topography, the ease with which the type is cultivated, and the wide adaptation and productiveness, the agricultural value is relatively high, ranging from about $20 to $40 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Upshur Silty Clay Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24617,24619	Soil	0.1	0.5	0.6	2.5	2.9	68.2	25.0
24618,24620	Subsoil .	2.0	1.8	1.5	4.4	6.6	39.2	44.6

Dekalb Silt Loam.

The soil of the Dekalb silt loam is a gray to grayish-brown, light silt loam about 8 to 10 inches deep. The subsoil is a pale-yellow, fairly heavy, compact silt loam to silty clay loam which becomes slightly heavier as depth increases, sometimes passing into silty clay below 30 inches. In places the lower subsoil has a slight Indian red cast. Such areas are

inextensive and really represent a gradation toward the Upshur.

The Dekalb silt loam is an upland residual type and is formed by the weathering in place of massive, fine-grained sandstone and shales.

The topography of the type is level to gently rolling. Weathering has taken place to the depth of 6 to 10 feet, and very few fragments of shale or sandstone are encountered in the soil to a depth of 36 inches. Drainage is usually good and in some places excessive.

The Dekalb silt loam is fairly well developed in the Point Pleasant area. An intermittent belt is found on the low flat ridge tops in the southern part of Jackson county and extends into Putnam county, following the outcropping of the Waynesburg sandstone. Typical areas occur around Kentuck, Paradise and Hugo. A considerable area is found in the vicinity of Upland, Mason county, and well developed areas occur on the low hills back from the Ohio river south of Letart. Small bodies occur in all parts of the area, usually as flattened ridge tops or shelf land.

The Dekalb silt loam is not naturally a strong soil, and in nearly all parts of the area it has been improvished by constant cropping. Very few instances were noted where the soil was not deficient in organic matter. It is easy to cultivate, owing to the loose structure of the soil, and responds readily to commercial fertilizers, manures, and the turning under of green crops or other organic matter. It also shows wonderful improvement following crops of the legumes.

Nearly all of the general farm crops of this section are grown upon the type. Except where fertilizers are used or where the type has been improved by careful tillage, the yields are generally rather low. Wheat produces 10 to 20 bushels, corn 15 to 50 bushels, oats 20 to 30 bushels, potatoes 100 to 150 bushels, hay 1 ton, and tobacco from 800 to 1,000 pounds per acre. Grass does not make an especially vigorous growth, and very little of the type is in pasture or mowing. The clovers do not thrive, but other leguminous plants such as cowpeas, soybeans, and vetch do well. The type does not produce as heavy yields of tobacco as the other heavier soils, but gives a good

grade of Bright Burley. Tobacco is grown mostly upon this type in the southern part of the area. This is also a good soil for light truck, but the industry has never been developed. Vegetables are produced for home consumption.

The Dekalb silt loam is one of the best fruit soils of the area, especially for apples. The topography is well suited to orcharding. The trees make a vigorous growth. Peaches, pears, and plums do fairly well, but are only grown for home use and local markets. Small fruits, such as strawberries and raspberries, do well, but are grown very little.

A number of suggestions could be offered for the improvement of the type. Fertilizers should be used for wheat, tobacco and all crops that make a heavy draft upon the soil. For wheat, corn, and oats, about 200 to 300 pounds per acre of a brand analyzing 10-2-4 would likely prove profitable, while an application of from 300 to 600 pounds of the same grade would be beneficial in tobacco culture. Cowpeas or other legumes should be used in all rotations. The soil shows decided improvement from the turning under of such crops as cowpeas, vetch, and rye.

The use of fertilizers relatively high in potash would be profitable in connections with the production of peas and beans. Barnyard manure is particularly helpful to all crops and should be used as much as possible. The original forest growth consisted largely of white oak, chestnut oak, and chestnut. Most of this has been removed and the type brought under cultivation. Chestnut predominates among the few trees that are left. The type is known locally as "chestnut land."

The Dekalb silt loam is valued at $20 to $30 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type.

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
23704, 24587, 24589, 24607	Soil	0.2	1.0	1.1	4.4	4.0	75.3	13.6
23705, 24588, 24590, 24608	Subsoil .	0.2	.8	.9	3.8	5.8	63.3	25.0

Dekalb Loamy Sand.

The soil of the Dekalb loamy sand to a depth of about 8 inches is a light brown to dark yellowish brown loamy sand, loose and open in structure. The dark color is due to organic material and is proportionate to the organic content. The subsoil is a pale-yellow to yellow loamy sand or very light sandy loam which below 20 inches becomes sandier and coarser in texture. Partially decomposed sandstone of the parent rock is encountered in some places at about 30 inches below the surface, but the rock usually lies below 3 feet.

The type is formed by the weathering in place of a massive coarse-grained sandstone and is found in this area only upon or near the crests of ridges. The rolling topography and open structure of the subsoil cause excessive drainage, and crops often suffer for lack of moisture during dry spells.

The type covers relatively small areas and is found in its most typical and extensive development south of Arlee in the southern part of Mason county. A few small scattered areas are found near the Mason-Cabell county line. Other areas occur south of Bellgrove near the Roane-Jackson county line. One isolated spot is found at Sandtown in Mason county, where the subsoil has a slight reddish cast.

The Dekalb loamy sand is of low agricultural value. It is naturally not a very strong soil and is decidedly inclined to droughtiness. Fair crops of corn, wheat, oats, and rye can be obtained by liberal use of barnyard manure or commercial fertilizers high in nitrogen. Cowpeas do very well and are recommended for rotations aiming at an improvement of the soil. They can be used to good advantage in such rotations and if turned under will improve the structure of the soil. making it more retentive of moisture. An acreage application of 300 to 400 pounds of a fertilizer mixture analyzing about 8-2-4 is a splendid application for wheat, oats, and a number of vegetables, especially following cowpeas or other legumes. Where no leguminous crop has preceded, the nitrogen content should be increased or an application of 75 to 125 pounds of sodium nitrate made as a late side application. Garden crops do well, especially tomatoes, garden peas, radishes, beans and potatoes.

Peaches, apples, pears and small fruits do exceptionally well upon this type. Peaches pay better than any other fruit.

Grass gives poor results, the yields being light and the stand uncertain. The type should not be counted upon as well suited to grazing, but should be used for orcharding and the production of early vegetables and some general farm crop. This type gives a very high grade of tobacco, but the yields are low.

The native growth is largely pine, chestnut, and poplar. Many locust trees are seen in abandoned fields.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Dekalb loamy sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24585	Soil	0.4	11.4	31.6	27.7	5.8	15.1	7.7
24586	Subsoil .	.0	16.7	33.5	24.3	7.0	11.4	7.3

Meigs Clay Loam.

The Meigs clay loam is a rather variable soil derived from fine grained sandstone and gray and red shales. It occupies steeply rolling country—high hills, narrow ridges and slopes where the run off is rapid and consequent erosion rather severe.

In what may be considered its most typical development —the predominating soils—the Meigs clay loam consists of a grayish-brown silt loam to silty clay loam, underlain at 2 to 8 inches by yellowish clay, loam or clay, which at about 20 to 24 inches grades into reddish or mottled red and yellow clay. Scattered over the surface and disseminated throughout the soil section are fragments of partially weathered sandstone and shale. These fragments are rarely in sufficient abundance to have any marked effect upon tillage operations. Patches of Upshur clay too small to admit of practicable differentiation on the map occur throughout the type, marking outcrops of red shales. There are also many small occurrences of soil having a grayish surface and yellow subsoil.

These are mainly Dekalb clay loam, but they are not large enough to map. Such areas are usually found on narrow ridges and shelflike situations where the parent rock is either gray sandstone or shale. Also, that portion of the type lying just below the Nineveh limestone is more or less influenced by colluvial material derived from the limestone, usually to the benefit of the soil from an agricultural standpoint.

"Slips" or landslides are common in this type caused probably by the absorption of the heavy loads of water by this soil occupying steep positions. These slides have played an important part in bringing about soil diversity. The drainage of the Meigs clay loam is excessive especially where the underlying rock comes near the surface, causing no little injury to crops in dry spells. Erosion is so active that a very considerable proportion of the type—the steeper slopes—should never be plowed, but left in forest or used for pastures.

The type occurs in large areas in the eastern part of Jackson county along the Roane county line, and extends into the central and southern parts of the county, mainly upon the ridge tops. The type is largely developed in the eastern-central and southern parts of Mason county, and in all parts of Putnam county it is the predominant soil.

Much of this type in Jackson county is in forest owing to the large area of adjacent soils better adapted to agriculture. But in other parts of the area much of it is cleared and is in pasture. Very little of the type is under actual cultivation. Cultivated crops should only be grown on the gentler sloping areas. A considerable part of this land can, however, be used for grass and pasturage. The type is naturally productive, and would be a very desirable soil, but for its unfavorable topography which precludes cultivation or the use of improved machinery over extensive areas. Corn, hay and tobacco are the principal crops. Corn produces 15 to 45 bushels per acre, according to season and care of cultivation; wheat, 6 to 20 bushels, averaging about 10 bushels; and hay from three-fourths to 1 ton per acre. Clovers do not give good returns, but cowpeas do exceedingly well and should be grown more extensively. Vegetables are grown for home use only. Tobacco is given a good deal of attention on

the type and gives good yields, about 1,000 pounds per acre being the average yield. Fresh land is nearly always used for this crop. Bluegrass grows naturally upon the type in nearly all parts of the area. A good sod is developed capable of supplying good pastures except during long dry spells. The chief drawback is that the sod does not last. The grass gradually thins out, rarely holding a good stand and giving way to broom sedge or other vegetation. More effort should be made to check advancement or undesirable vegetation by reseeding and cutting out shrubbery and by making broadcast application of lime and probably phosphatic fertilizers.

Phosphatic fertilizers should be used with cultivated crops. Bone meal also (300 to 500 pounds per acre) should be used when possible for crops intended to be followed by grass.

Locust trees spring up very quickly in abandoned fields. The growing of these for posts and other uses should prove profitable. The utilization of areas most susceptible to washing for such purposes should certainly receive more attention.

Apples, peaches, pears, plums, and cherries do well, but only the smoother crests of hills and ridges and the gentler slopes and shelflike situations should be used for fruit. Commercial orcharding ordinarily would not pay upon the steep hillsides. Grapes do well upon this type. Good vineyards sites are numerous.

Blackberries and raspberries are not grown to any considerable extent, but make good yields when given the proper care. Apples would probably be found to pay better on the type than other fruits. The Ben Davis does exceptionally well.

The natural forest growth is largely oak, hickory, and walnut with chestnut upon the higher phases. Oak and locust are the predominant second-growth species.

The type is valued at from $10 to $20 an acre.

Brooke Clay Loam.

The surface soil of the Brooke clay loam as typically developed is a grayish-brown to yellowish-brown heavy clay

loam 3 to 6 inches deep. It is friable when dry and very plastic and sticky when wet. It cracks badly on drying and packs in the roads with a smooth glistening surface. Boulders of bluish colored limestone, varying in diameter from 1 to 2 inches to several feet are found scattered on the surface and in a few places render cultivation difficult.

This subsoil is a pale yellow to yellowish-brown heavy plastic and tenacious clay to about 20 to 30 inches where the texture becomes lighter and often the parent limestone is encountered. Fragments or unweathered portions of this limestone are of common occurrence throughout the soil mass.

The Brooke clay loam of the Point Pleasant area is derived in place from the Nineveh limestone, which is an extension of the same formation that gives rise to this type in the southern part of Wood and the western part of Wirt counties. The formation has a maximum thickness of about 50 feet near the northeast boundary of Jackson county and thins toward the west. In places, it is interbedded with shale and sandstone, but the greater part of the soil is derived from pure limestone. Along the Wirt county line the type is found upon the crests of ridges and hills above the 1,000-foot contour line. The formation dips slightly toward the Sandyville syncline. The type is found at the lowest levels in the area of the syncline and probably reaches its lowest horizon at Browning where it occurs at about 980 feet. The formation rises to the west from the syncline and last western remnant of the formation occurs on Utah Hill at about 1,050 feet elevation.

This is not an extensively developed soil, being found only in the northwestern part of Jackson county.

Just below the lower strata of the Nineveh limestone a thick bed of greenish-red calcareous shale is found. Where the material derived from the two formations is intermingled, a light-brown phase of the type is encountered. Lying on the crests of high hills and ridges the drainage of the Brooke clay loam is good. It conserves moisture in amounts favorable to good crop growth, there being very little suffering from drought. Care should be taken not to cultivate when the soil is wet enough to be sticky, as puddling or severe bak-

ing is likely to follow on account of the high lime content; however, clods usually crumble down much more rapidly than in case of similar heavy soils lower in lime. The best time to plow the type is in the late fall or during January or February, not so much to take advantage of the winter freezing, as to prepare the land in time to secure the proper seed-bed condition for spring planting. Delayed plowing in the spring often prevents the proper preparation of the soil until the season is too far advanced.

Erosion is largely held in check by the excellent bluegrass sod covering much of the type.

The Brooke clay loam is the strongest upland soil in the area. It produces good yields of the general farm crops without the use of commercial fertilizers. Tobacco probably gives the best returns of any crop grown. From 1,000 to 1,200 pounds per acre is generally secured, although as high as 2,000 pounds is not unusual

A very high grade of Bright Burley type of tobacco is grown on the land. It is upon this type that the tobacco industry in Jackson county is largely maintained.

Wheat yields from 15 to 35 bushels per acre, but it is a rather expensive crop to handle on this high-lying type of soil. Corn yields range from 40 to 60 bushels per acre, and oats from 30 to 60 bushels. Vegetables and potatoes are grown with success, but mostly for home consumption. Apples do not thrive, the trees for some reason being short lived. Peaches give splendid results, varieties like the Elberta and Crawford bringing good returns. Cherries and plums also do well. Such fruit as blackberries and raspberries are grown only in a limited way.

Clovers, cowpeas and soybeans flourish. Alfalfa also does well when once established, but considerable trouble is encountered in getting a good stand. Timothy yields from 1½ to 2 tons of hay per acre, and the pasturage is good even during the dry seasons. Bluegrass sod lasts for an indefinite period. Fields were seen that were 40 years old and still in splendid condition.

The raising of live stock on a type so well suited could not but give profitable returns, the greatest drawback being in the

extent of the type. Sheep produce a splendid quality of wool. Cattle make a vigorous healthful growth and can be profitably handled without finishing on corn. The growing of pure-bred stock for breeding purposes is strongly recommended.

The agricultural practices are mainly well suited to the soil, and the farmers in general are using modern methods. A common rotation is tobacco two years, followed by wheat and then by clover. The growing of more leguminous crops and the turning under of cover crops or other vegetable matter are recommended to improve the physical condition of the soil.

Commercial fertilizers do not give profitable returns, except with tobacco.

The original forest of hardwood has been nearly all cleared away and the most of the type is in pasture. It is valued at about $30 an acre. This estimate is for farmers, including some hillside areas of other inferior soil types. The type segregated would be valued much higher.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Brooke Clay Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24581	Soil	1.5	9.7	7.3	13.8	6.7	38.3	22.4
24582	Subsoil .	.0	.4	1.0	3.7	.7	44.7	40.5

Rough, Stony Land.

The rough, stony land comprises the rocky cliffs and steep land upon which the abundance of rock and steepness of slope preclude cultivation. Such areas occur largely where strata of hard massive sandstone outcrop. The formations giving rocky cliffs are principally the Waynesburg and the Pittsburg sandstones. Areas are also derived from the lower Dunkard, Monongahela, Mahoning and Charleston formations. Other small detached spots occur in various parts of the area. Some of these are too small to show on the map.

Rough, stony land is worthless agriculturally and should be left in forest. as most of it is at the present time. The

principal growth is oak and sprucepine. Rhododendron and laurel are found in some places.

Huntington Silt Loam.

The Huntington silt loam consists of a brown to dark-brown mellow silt loam which gradually becomes lighter in color, passing at about 12 inches into light-brown, slightly-compact, silty clay loam. In places the soil is slightly sandy, especially in stream channels Minute flakes of mica are common throughout the soil section. The soil in some of the lower places or swales, where water stands longest after overflows, is heavier than the typical soil and shows considerable cracking upon drying. Faint grayish mottling is sometimes seen in the subsoil of the poorer drained areas.

Occasional small fragments of shale and sandstone are found on the surface and in the underlying material, especially in the type as developed in the bottoms of the smaller streams. In many places along the smaller streams, beds of gravel are found two to four feet below the surface.

The Huntington silt loam is an alluvial soil and occurs only in the first bottoms of streams. It is subject to frequent overflow and consequent repeated addition of alluvial sediments.

The topography is usually level. A slight indentation is seen here and there, owing to occasional depressions or swales and slight swells. Notwithstanding the level topography and low position, the drainage is usually very good, and only a few areas need artificial drainage. The frequent inundations continually add extremely fertile sediments rich in organic matter, making the use of fertilizers or manures needless. The land can be cropped year after year without showing any signs of impoverishment. However, it should not be plowed when wet enough to be decidedly sticky, as clods are apt to be formed, although injury from this source never lasts for any considerable time. Where there is considerable wash from the red Upshur and Meigs soils, the type has a reddish cast, making it difficult to draw boundaries between this and the reddish Moshannon soils. The Huntington silt loam, as developed along the Ohio river, is of a darker color than that along the

smaller streams, and is much freer of rock fragments. The soil here is considered the most valuable portion of the type for one reason, because overflows are not so common during the growing season.

The Huntington silt loam is considered the best corn land of the area, and about one-third of the entire acreage of the type is planted to this crop each year. The yields range from 40 to 100 bushels per acre. In that portion of the area that lies to the south of the Great Kanawha river, tobacco is grown extensively upon this type. While the yields are large, the color is dark and the quality of the leaf is inferior to that grown in the uplands. There is considerable danger of losing the tobacco crop upon areas along the small streams by floods in June or July. Wheat ,oats and rye lodge badly and are not extensively grown.

Some of the type is too heavy for potatoes, but upon the better-drained, lighter areas both Irish and sweet potatoes give splendid results. Broom corn is grown to some extent, mostly in Sandy creek and Mill creek bottoms. Sorghum is grown upon this type in small patches in all parts of the area, giving a bright colored sirup. Good crops of timothy are grown, but there is some danger from lodging. A number of grasses do well and afford excellent grazing even during dry seasons.

"Iron weed" seems to be the greatest menace to pastures upon this land. It is necessary to keep such noxious weeds well under control, for if once well established, they are very difficult to eradicate. The type produces good garden and truck crops, especially tomatoes, cucumbers and cabbage.

Orchards should never be located upon this type, as the situation is not suited to the healthful growth of fruit trees. The native trees. largely sycamore, maple, elm and beech, have been removed, and the type is in mowing or in cultivated crops.

The price of land of this type of soil ranges from $50 to $100 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Chemical Analyses of Huntington Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24603	Soil	0.0	0.1	0.6	4.5	5.9	68.6	20.0
24604	Subsoil .	.0	.0	.2	1.8	8.9	64.6	24.4

Huntington Loam.

The soil of the Huntington loam to a depth of about 10 to 15 inches is a dark-brown loam, open, friable and loose in structure. The subsoil is slightly lighter in color and a little heavier in texture than the soil. The occasional slight ridges found in areas of this type are noticeably lighter than the average, the content of fine and very fine sand being somewhat greater in such positions, while the soil in the swales is much higher in silt than in the predominant type. This type lies somewhat higher than the Huntington silt loam, but it, too, is subject to overflow, though not so often as the silt loam. These occasional inundations serve to maintain the productiveness of the soil. Crops are rarely damaged by overflows.

The topography is mainly level. There is a slight undulation due to the presence of occasional low ridges and shallow swales. The drainage conditions in the main are excellent. There are a few low spots where tiling or ditching could be done to advantage.

The Huntington loam occurs in narrow strips intermittently along the Ohio river, about 40 to 50 feet above the stream. It is found in its most typical development in the bottoms near Ravenswood.

The type is easily cultivated, but has a slight tendency to clod when plowed too wet. This is not a serious drawback, however, especially with the lighter phase, as the clods are very easily pulverized.

Wheat, oats and rye give good yields and are grown to some extent, notwithstanding the tendency to lodge. Corn yields an average of about 60 bushels per acre. About one-third of the type is used for this crop. Tomatoes, sweet potatoes and Irish potatoes do better here than on any other type in the area. Irish potatoes yield about 150 bushels per acre.

Grasses and forage crops grow luxuriantly, but the type is too valuable to be used for pasturage or for forage crops, except the legumes grown in rotation with other crops. Heavy yields of ensilage could be secured and undoubtedly would pay with dairying. There is little need for fertilizers or manures. Lime would probably benefit the poorer drained swale areas.

The value of this type ranges from $100 to $150 an acre. This high price would warrant a considerable outlay to bring all poorly drained areas into good condition even if expensive tiling were necessary.

The original forest growth, consisting largely of walnut, beech and sycamore, has been removed, and the type is practically all under cultivation.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Huntington Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24597,24599	Soil	0.0	0.4	4.5	27.8	15.1	38.6	13.4
24598,24600	Subsoil .	.0	.3	5.7	32.1	19.2	28.3	14.8

Wheeling Silt Loam.

The soil of the Wheeling silt loam is a friable brown silt loam to silty clay loam about 10 to 12 inches deep. The subsoil is a light-brown to yellowish-brown, friable but slightly compact silt clay loam. This becomes lighter in color and slightly more compact as depth increases. Faint grayish mottling is noticed in the lower subsoil in the poorer drained situations.

The type occurs on second and third terraces along the Ohio river, where it represents material deposited by the river when it was flowing at much higher levels. The material is believed to consist largely of glacial particles. This is borne out by the frequent occurrence of beds of glacial gravel that underlie much of these terraces. A certain amount of material, of course, comes from non-glaciated regions and in places colluvial wash is in evidence along the outer margin of the terraces near the foot of the uplands.

The type occurs interruptedly along the Ohio river, the largest developments being in Mercer Bottoms, near Ravenswood, and to the north of Point Pleasant. The topography is level to very gently undulating in places. Some deep gullies are seen near the bluff lines or drops to lower levels. and it is probable that much of the original formation has been cut away by the river. The drainage, except for a few swales and level areas, is excellent. The gravel beds underlying a large part of the type favor perfect underdrainage. The areas lie above overflow even during the high spring freshets.

The Wheeling silt loam is the strongest type of the Wheeling series, and has received more attention than any other member of this series. Much of it has had its organic matter content reduced under a system of constant cropping without returning sufficient vegetable matter to replace that lost through hard use. This practice is largely responsible for the low yields obtained in some places.

The type is a good general farm crop and vegetable soil. It supports a good sod of grass under all conditions, and legumes such as cowpeas and clover flourish with about equal success. Irish potatoes give profitable returns, and a large acreage of this crop is put in every year. The average yield ranges from about 150 to 200 bushels per acre, while a yield of 300 bushels is not unusual. Tomatoes also do well, but are grown more extensively upon the lighter Wheeling types. Cabbage, beans, asparagus, spinach, cauliflower and onions should do well. Corn yields about 50 to 75 bushels per acre; wheat, 15 to 35 bushels; oats 20 to 40 bushels; buckwheat, 15 to 20 bushels; hay, one ton to two and one-half tons per acre. Apples give very good results, especially the Grimes Golden and Rome Beauty. The fruit is said not to color up as well as on some of the upland soil, though it has an excellent flavor. Very few orchards, however, have been set. Considerable nursery stock is grown on the type.

The type is not in need of commercial fertilizers, but should receive liberal applications of organic manures, such as barnyard refuse and cowpeas or clover turned under green. The legumes improve the soil materially for succeeding crops like corn, wheat, oats and potatoes. The spots that show gray

or drab mottled in the deep subsoil are in need of tile drainage and lime.

The soil is not difficult to handle, being easily cultivated and easy to keep in a very desirable mellow tilth.

The Wheeling silt loam is a highly desirable agricultural soil. It is all cleared and under cultivation, and is held at from $75 to $150 per acre, according to improvements. Very little is for sale.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Wheeling Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24639,24641	Soil	0.1	0.8	1.3	3.2	8.2	59.1	27.3
24640,24642	Subsoil .	.1	5.6	6.5	4.0	9.9	49.6	24.0

Wheeling Fine Sandy Loam.

The soil of the Wheeling fine sandy loam is a light-brown to brown, mellow, fine sandy loam, about 12 to 14 inches deep. There is a gradual change into a lighter colored or yellowish brown, slightly compact subsoil which has nearly the same texture as the soil to a depth of about 30 inches, where it becomes somewhat lighter.

The type occurs as second and third terrace interruptedly along the Ohio river. It is found in largest areas and most typical developed north of Point Pleasant, in Mercer Bottoms and south of Willow Grove. The type was deposited by the Ohio river upon former flood plains that now stand above overflow. It is derived from glaciated areas. The surface is somewhat undulating, owing to the frequent occurrence of slight ridges, the tops of which are sandy, while the intervening depressions are silty. The drainage is good but not excessive under usual seasonal conditions. Crops, however, have a slight tendency to suffer during protracted dry spells.

This is not as strong a type as the Wheeling silt loam. It is deficient in humus to a very noticeable degree. The use of commercial fertilizers in fairly liberal amounts will be found

beneficial to potatoes and melons, as well as for the general farm crops like wheat and oats. Leguminous crops, especially cowpeas and soybeans, should be used in rotation with the general farm crops and with vegetables. The type is easily cultivated, and little difficulty is experienced in handling it. The low yields are usually due in a large measure to the depletion of organic matter. Crops like cowpeas and rye should be turned under to remedy their deficiency. The average yield under favorable conditions are: Wheat, 15 to 35 bushels per acre; sweet or Irish potatoes, about 150 bushels per acre. Rye does well and oats fairly well. The type is not adapted to grass and makes very poor meadow. Corn does only fairly well. The soil makes good crops of melons, tomatoes and a number of other vegetables. A considerable area of this type is planted to melons each season.

All the type is cleared and under cultivation, and is valued at about $100 to $125 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Wheeling Fine Sand Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24635,24637	Soil	0.8	8.2	7.7	29.8	16.0	28.4	8.9
24636,24638	Subsoil .	1.1	8.3	7.0	30.8	11.6	31.7	9.2

Wheeling Sandy Loam.

The soil of the Wheeling sandy loam is a light-brown to brown, medium to coarse, rather light sandy loam, 10 or 12 inches deep. A small quantity of gravel is found in the soil and scattered upon the surface, but the proportion is not sufficient to effect the character of the soil. The subsoil is a yellowish-brown, light sandy loam, containing a slightly larger per cent of gravel than the soil. Below 30 inches the gravel content increases and the material has almost the texture of a gravelly sandy loam.

The topography is level to gently undulating, giving good surface drainage, while the gravel bed lying from 4 to 10 feet below the type promotes underdrainage.

Much of the material forming this soil is glacial in origin. It was deposited when the Ohio river was flowing at a higher level than now. The coarseness of the material indicates that the deposits were made in a comparatively swift current.

The type occurs in oblong areas parallel to the Ohio river and occupying a position upon the second bottom terrace lying from 40 to 80 feet above the present water level and above overflow. It is found in its most typical development in Mercer Bottoms, Ravenswood Bottoms, near Graham station, and to the north of Point Pleasant.

In agricultural value the type stands next to the Wheeling silt loam. It produces good crops of truck and general farm crops. Large areas of the type each year are planted to melons. Good crops of tomatoes are grown. Potatoes, cabbage, onions and beets are paying crops. Rye does better than any other cereal. Wheat, when well fertilized, yields from 25 to 30 bushels per acre. Grasses, as a rule, do not flourish, and very little of the type is in mowing lands.

About 200 pounds of an 8-1-4 fertilizer is used with heavy truck crops, but for ordinary farm crops little or no commercial fertilizer is used. The growing of legumes is generally practised and gives excellent results. Fruits do well upon this type. The use of fertilizers high in phosphorus and potash are recommended for crops that make heavy draft upon the soil.

The use of leguminous and cover crops and stable manure are also recommended.

All of the type is cleared of its natural forest, and nearly the entire acreage is planted to cultivated crops each season.

Land of this type of soil is valued at $75 to $125 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Wheeling Sandy Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24627,24629	Soil	3.0	26.3	30.7	7.5	6.7	18.4	7.1
24628,24630	Subsoil .	2.4	27.9	33.4	7.8	6.0	15.1	7.2

Wheeling Gravelly Loam.

The soil of Wheeling gravelly loam, usually about 10 or 12 inches deep, is a brown to dark-brown gravelly loam of loose open structure. The subsoil is a light-brown or yellowish-brown gravelly loam containing a larger percentage of gravel than the soil. Below three or four feet is encountered a gravel bed that extends to a depth of more than 10 feet. Gravel is scattered over the surface and disseminated through the soil mass in amounts ranging from about 30 per cent in the soil to 50 or 60 per cent in the subsoil. The gravel range in size from very small to about one inch in diameter and consist largely of rounded quartz with some quartzite, granite, sandstone and other rocks.

The interstitial material is silty in character and slightly heavier in the soil than in the subsoil.

The material composing the Wheeling gravelly loam is probably mainly from glacial sources, and represents the alluvial deposits of the Ohio river when it was flowing at a higher level. The type occurs in small but well-defined areas on the high terraces of the Ohio river. The most typical development is that near Willow Grove. Small areas also occur below Mason City and Spilman.

Level to gently rolling topography is characteristic of this soil. Even in the level areas the open structure and presence of underlying gravel beds give to the type thorough to excessive drainage. During dry seasons crops suffer for want of moisture. In wet seasons, when crops on other heavier soils suffer severely from excessive moisture, good results are had on this land.

The type is not naturally productive, but has been built up by use of manure, lime, cowpeas and the incorporation of organic matter by plowing under of cover crops. As a result the yields are surprisingly good for a type of this character. Wheat yields from 15 to 30 bushels, and corn from 40 to 50 bushels per acre. Oats and rye do well when the seasons are not too dry. Irish potatoes yield 100 to 150 bushels per acre. Melons and tomatoes are paying crops. Cowpeas and a number of other leguminous crops grow luxuriantly. The type is well suited to apples, the fruit having a fine flavor, though not

as good a color as could be desired. Small fruits such as cherries and plums do well also.

The present method of handling the type seems to be about the best system that can be used. By turning under cover crops the soil is made much more retentive of moisture and then changed from what might be considered a good wet season soil to a soil capable of giving good returns with a large number of crops under varying seasonal conditions and made to produce good crops in any season.

Although the type contains a high percentage of gravel, this does not interfere with cultivation. Deep plowing can be easily accomplished.

The type is valued at $75 to $125 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Wheeling Gravelly Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24625	Soil	16.1	16.2	8.3	9.4	4.0	26.8	18.0
24626	Subsoil .	16.3	15.0	8.4	8.0	5.6	27.4	19.0

Wheeling Fine Sand.

The Wheeling fine sand is a brown or light-brown incoherent fine sand about 12 inches deep. It is loose and open when dry and rather compact when wet. The surface has a grayish appearance when thoroughly dry and a decided brownish cast when wet. The color is also an indicator of the organic content, the gray soils being markedly deficient in vegetable mater. The subsoil is a yellowish-brown, incoherent fine sand, becoming lighter in color as depth increases.

The type occurs as undulating or sloping land next to the upland here and there along the Ohio river. The most typical areas are found northwest of Ravenswood and between Spilman and Point Pleasant.

The materials composing the Wheeling fine sand have probably come chiefly from the glacial region, as in the case of the other Wheeling soils. The dune-like surface unquestion-

ably is due in part at least to the action of winds. Some areas have been blown up the lower slopes of the uplands for some distance; the material in such places being much deeper than over the remainder of the areas.

Drainage is excessive, owing to the loose open structure and low organic matter content of the soil, and crops suffer from lack of moisture even during moderately dry seasons. The turning under of green crops is practiced to make the type more drought resistant.

Cultivation is naturally very easy, requiring very light draft for deep plowing. It is best suited to the production of melons and early vegetables. A large area is planted to melons yearly, and these yield greater profit than any other crop. The type is not suited to general farm crops or heavy truck crops. The well-drained conditions and open sandy nature of the soil make it warm up early in the spring—a feature that favors the production of early vegetables like garden peas, radishes and lettuce. Sweet potatoes give excellent yields, but have a tendency to grow in a stringy shape. Irish potatoes do not give as heavy yields as on the other Wheeling types, but for an early crop this soil is the exact kind required. Fair crops of rye are obtained where not planted too thick. Other grain crops give very poor returns.

The type can be prepared for seed bed earlier than the other types of the area, as the wet cold springs cause little delay. It is advisable to use commercial fertilizers. A mixture high in phosphoric acid and potash should be chosen and the nitrogen supplied through the growing of leguminous crops. If very soluble forms are used, the fertilizer should be applied as a top dressing during the growth of the plants.

Nearly all the type is cleared and under cultivation, and is valued at $90 to $100 an acre.

Tyler Silt Loam.

The soil of the Tyler silt loam is a grayish-brown, fairly heavy and slightly compact silt loam, about 10 inches deep. The subsoil is a yellowish-brown, compact and slightly plastic heavy silt loam or silty clay loam to silty clay. Drab and gray mottlings with occasional dark-brown or black iron oxide

colors are frequently encountered below 20 inches.

The type occurs as second bottom or terrace land along the smaller streams and in the ancient river beds, where it is probably a lacustrine deposit. The particles are very fine and have a smooth feel. It is known locally as "soap land." Areas are found along Sandy and Mill creeks, in Jackson county, and along the Great Kanawha river. Small bodies are also found in all parts of the area as second bottom, lying usually from 30 to about 100 feet above the lowest bottoms. The material comprising the type is probably derived largely from the lighter colored upland soils of the region, such as the Dekalb, although poor drainage conditions probably account in part for the development of the lighter color.

A few areas are noticeably sandy, representing probably depositions in more rapidly running water. The grayish mottling in the subsoil is due to poor drainage conditions.

The type is underlain in many places by sandstone which sometimes lies within the three-foot section. Areas in the valleys of streams emptying into the Ohio river were probably laid down about the same time as the Wheeling soils, the material being derived, however, from a different source.

During dry spells the surface of the type becomes grayer and more compact. Cultivation is very difficult whether the type is wet or dry, it having a strong tendency to clod when wet, and being all but impossible to plow when dry. Many forms of clod-breaking machinery are employed in its cultivation. The roller seems to be the most popular. The type in general, especially the lower, flatter portion, is acid and in need of underdrainage and lime.

Of the general crops grasses do best upon the Tyler silt loam, and a large area is in mowing and pasture. Timothy yields one and one-half to two tons of hay per acre. Corn produces only fair crops. The average yield of wheat is very low, but where drainage conditions are good and some attention has been given to building up the type, 20 bushels to the acre is not unusual. Truck crops cannot be grown to advantage, and only in a few places upon the lighter phase do gardens flourish. Fruits, especially apples, do well on the higher lying terraces, and many large orchards are found. Tobacco does fairly well and is grown on this type to some extent in the southern part

of the area along the Kanawha river and Teays Valley. Leguminous crops cannot be grown to advantage in the present condition of the type. Drainage and lime are very necessary before any method of upbuilding can be successful. After this is done, if it is followed by deep plowing and the incorporation of as much organic matter as practicable, the formation of a deep loamy soil will result upon which nearly all the field crops of this section can be grown successfully.

All the original growth, largely beech, oak and poplar, has been removed. The price of land of this type of soil varies from $50 to $100 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Tyler Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24613	Soil	0.2	1.8	2.3	3.6	1.5	72.8	18.2
24614	Subsoil .	.2	.8	1.0	1.5	1.1	57.9	37.4

Tyler Silty Clay Loam.

The Tyler silty clay loam is a gray to grayish-brown compact silty clay loam, underlain at about 10 to 12 inches by a rather plastic silty clay of a grayish-brown or pale yellow color, sometimes slightly mottled with gray in the lower portion.

The material represents old alluvium. It occurs in Teays Valley near the mouth of Sandy creek, where it is known as "Soap Hill" and along Old Town creek.

This land is also locally styled "crawfish land." It is a rather clammy, cold matured soil of only moderate productiveness. It is best suited to grasses, although with liming and the liberal incorporation of vegetable measures good yields of wheat and fair corn can be secured. Some of the flatter areas need drainage.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical Analyses of Tyler Silty Clay Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
23706	Soil	1.3	4.2	3.8	5.0	7.8	50.1	27.7
23707	Subsoil .	.3	1.4	1.0	1.0	9.6	44.9	41.5

Holston Silt Loam.

The soil of Holston silt loam, to a depth of 10 or 12 inches, is a yellowish-brown or light-brown, slightly compact, friable silt loam. The subsoil is a brownish-yellow to yellow, friable, heavy silt loam to silty clay loam, becoming very compact and approaching a silty clay loam in texture in the lower part of the profile. Practically no water-worn pebbles or fragments of sandstone or shale are found in the soil or subsoil. Beds of laminated clays are found in places usually 10 to 50 feet below the surface, and occasionally exposed in large areas, giving rise to a heavy phase of the Tyler silty clay loam. The occurrence of these laminated clays would seem to prove conclusively that the type was formed by deposits upon the bed of a stream which formerly flowed through Teays Valley.*

The courses of the streams were changed, as no past stream action is shown except by small local drainage ways. Very little residual material is encountered in the type, and it is found only where the original bed rocks have been exposed by erosion. The original deposit has been dissected to some extent by erosion, giving the type a gently rolling topography. However, level terraces covering a considerable area are found usually supported by massive sandstone strata.

The drainage is usually good, except in spots where the beds of laminated clay or sandstone strata prevent free underdrainage. These spots are usually acid and have the drab or gray mottlings in the deep subsoil. They are of small extent, and their unfavorable condition can be easily remedied by tile drainage and liming.

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*For an explanation of the method of deposition of the Teays Valley Sediments, see Huntington Folio of the United States Geological Survey, and also a paper by I. C. White read at the Minneapolis meeting of the A. A. A. S., 1880.

The type occurs developed in the ancient streamways and upon the ancient terraces of the Ohio and Kanawha rivers. The largest areas of the type occur in Teays Valley and in the northwestern part of Mason county, between Point Pleasant and New Haven. Ancient high terraces occur between Ravenswood and Millwood, and are represented by the low flat uniform ridge tops back from the Ohio river. The type usually occurs from about 100 to 200 feet above the present first bottoms of the large streams and 650 to 750 feet above sea level. It is formed largely of the wash from sandstone and gray shale formation, little red material entering into its composition.

The Holston silt loam is not a strong soil, but is easily tilled and readily brought to a high state of cultivation. It produces good crops of wheat, oats, rye, corn, tobacco, potatoes, peas, beans and hay. Wheat yields from 15 to 25 bushels per acre; corn, from 20 to 60 bushels; oats, from 20 to 30 bushels; potatoes, from 150 to 200 bushels; tobacco, from 800 to 1,200 pounds, and hay, from one to two and one-half tons. Cowpeas, soybeans, vetch and rye do well and are used to some extent in rotations. Clovers do not thrive, and consequently are grown only to a limited extent. Wheat is grown extensively, but the other cereals, with the exception of corn, are grown in small quantities. Potatoes are an important crop, the acreage being second only to that on the Wheeling soils. It is also good truck soil, producing fine crops of nearly all the vegetables grown in the area, especially tomatoes, cabbage, onions and beans. A very high grade of Bright Burley tobacco is produced. The soil gives a tough leathery leaf used largely for plug wrapper, for which a good price is readily obtained. The yields are not so heavy as upon the bottom land or limestone soils, but the quality more than makes up the difference. Tobacco is grown upon this type on a large scale in Teays Valley.

The Holston silt loam is the best fruit land in the area. Apples do better than the other fruits, but all varieties grown in this section of West Virginia seem to do well. The trees make a thrifty growth, and the fruit has a high color and fine flavor. This is especially true of the phase of soil found on the low hills back from the Ohio river. These ridges present ideal

orchard sites, having perfect air drainage and being level enough to permit the use of spraying machinery. It is largely upon this type that the apple industry in the vicinity of Ravenswood and Letart is developed. Ben Davis, Rome Beauty and York Imperial are the varieties grown largely in commercial orchards. Of the small fruits strawberries are particularly satisfactory.

Fertilizers are used to a larger extent upon this type than on any other soil in the area. This is largely due to the fact that the land was cleared early in the settlement of the country and has been cropped heavily. For wheat, 200 to 400 pounds of a 8-2-4 mixture, or 200 to 300 pounds bone meal, or 200 to 250 pounds ammoniated phosphate is used. For tobacco, 400 to 600 pounds of a 12 2-4 has been found satisfactory. For corn, stable manure is usually employed. A top dressing of 150 to 250 pounds of nitrate of soda is sometimes used on oats, wheat and corn with good results.

The turning under of cover crops has been practised of late years by many of the leading farmers, and has done much to build up this type. The more general use of leguminous crops is recommended.

The original forest growth, consisting largely of oak, hickory, beech, walnut and chestnut, has been practically all cleared way and the type is generally under cultivation.

The Holston silt loam is a very desirable soil for general farming, fruit, tobacco and trucking, and presents a rare opportunity for special or diversified farming. Its nearness to cheap and efficient transportation makes it one of the high-priced types in the area. Very litle of the type is for sale, but prices generally quoted range from $60 to $100 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical Analyses of Holston Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24591	Soil	0.3	1.0	1.2	4.2	3.0	78.5	11.2
24592	Subsoil .	.0	.7	.9	4.5	5.4	69.5	18.6

Moshannon Silt Loam.

The soil of Moshannon silt loam is a reddish-brown to dark Indian red or chocolate red, mellow silt loam, about 10 to 12 inches deep. The soil, if cultivated wet, hardens to a certain extent on drying, causing the formation of clods in plowing. When plowed in the proper moisture condition an excellent, mellow tilth is secured. Unlike the Huntington silt loam, there is generally a distinct line of demarcation between the soil and subsoil. The subsoil is a fairly compact, friable chocolate red or Indian red to reddish-brown, heavy silt loam, becoming more compact in the lower portion. Beds of sandstone and shale fragments are frequently encountered at about two and one-half to four feet below. A few fragments are scattered over the surface and disseminated throughout the soil and subsoil, but not in sufficient quantities to offer material hindrance to cultivation.

The Moshannon silt loam is an alluvial first-bottom soil composed largely of material washed from the Upper soils and the Meigs clay loam. It is found largely in the eastern part of Jackson county, where the Upshur and Meigs soils are extensively developed.

The topography is mainly level and the drainage good. That portion of the type next to the foot of the uplands is more undulating and includes some colluvial soil.

The Moshannon silt loam has the general physical properties of the Huntington silt loam, but it is a slightly stronger soil with the probable exception of that portion of the Huntington developed in the Ohio river bottom.

Corn yields from 50 to 80 or 100 bushels per acre. Broom corn does well. Wheat and oats are not quite as likely to lodge as upon the Huntington silt loam. Yields of from one to two tons of hay per acre are easily made. Good pasturage also can be had on this land. Tobacco is not grown extensively, the product being about the same as on the Huntington soils, that is, a rather strong thick leaf. Leguminous crops do well and yield heavy crops of forage.

The original tree growth, largely sycamore, elm and beech, has been removed and nearly all of the type put under cultivation. Land of this type is valued from $30 to $75 per acre.

Moshannon Silt Loam, High-Lying Phase.

The soil of the high-lying phase is a dark-brown to reddish-brown silt loam to silty clay loam, about 10 to 14 inches deep. The soil changes gradually into a slightly compact, reddish-brown, silty clay loam to silty clay.

This phase occurs in narrow strips along the banks or the Kanawha river, extending on both sides with only a few breaks the entire course of the stream within the aera surveyed. This phase lies higher than the contiguous soils of the Kanawha first bottoms and is better drained. It was formed by the deposition of silt and clay during high overflows. The type is about 40 to 50 feet above the low-water mark of the stream and subject only to occasional overflows. These occur during the spring freshets once in about five to seven years. A few spots are found where the soil contains a relatively large proportion of fine sand, but these are of small extent

The topography is level to gently undulating. The occasional overflows serve to renew the fertility. Overflows during the growing season are rare. The type is of good texture and structure and is easily cultivated. It is the best type in the Kanawha Bottoms, and produces from 65 to 75 bushels of corn, 12 to 15 bushels of wheat and from one to one and one-half tons of hay per acre without the use of fertilizers. Oats do not give good results, and wheat has a tendency to lodge. Tobacco is grown to a small extent upon this type in Putnam county, and good results have been obtained with the Yellow Burley. Melons, potatoes and truck crops do well, giving the best results upon the lighter phases of the soil. Commercial fertilizers do not give sufficient increase in yields to warrant their use. All the type is cleared and under cultivation, and is valued at $100 an acre.

The following tables gives the average results of mechanical analyses of typical samples of the soil and subsoil and single analyses of the soil and subsoil of the high-lying phase:

Mechanical Analyses of Moshannon Silt Loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
24609,24611	Soil	0.2	0.8	2.1	9.5	6.9	62.6	17.8
24610,24612	Subsoil .	0.1	.5	2.2	12.0	11.2	48.3	25.4
High-lying phase:								
23698	Soil	.2	1.0	1.3	4.0	3.6	60.8	29.0
23699	Subsoil .	.4	1.6	1.6	3.7	17.7	45.7	29.4

Moshannon Clay, Erosion Phase.

The Moshannon clay erosion phase is a variable soil comprising a succession of slight ridges and depressions. The soil in the depressions is a compact gray to grayish-yellow silty clay underlain at 5 to 10 inches by compact clammy silty clay, mottled with gray or drab ,and brown with rusty brown and black concretions in the lower portion The soil has poor structural properties, is poorly drained and best suited to grass. In dry seasons cracks are abundant.

On the slight ridges the soil is usually a compact chocolate-brown, silty clay loam which quickly grades into silty clay. At about 18 to 24 inches it is underlain by silty clay mottled chocolate-brown and drab. This is a much better soil than that of the depressions, being well drained and well suited to corn, grain and forage crops, but the two are so intimately associated that usually different agricultural usage cannot be made of them. However, some of the broader swells are used for corn and grain, while the depressions are left in grass. It was not practicable to show these variations types on the map on account of the small size of the areas and their intricate arrangement. In places the depressions as well as the elevations are more or less rounded in shape.

The soil is found in the high bottoms of the Kanawha river where overflows occur usually not oftener than once during a period of four or five years. The phase usually lies somewhat lower than the more uniform soil, the Moshannon silt loam, next to the river and is more subject to overflows On the outer margin it is bordered either by higher lying bottom lands or terraces or by the upland slopes. But for the slight depression and swells the surface is level.

This phase of the Moshannon clay is very difficult to till owing to the prevailingly heavy character and also to the cold moist condition of the soil in the depressions. Most of the type is undrained and is used for pasturage and hay. Where drained, fairly good results have been obtained with other crops such as oats, corn and wheat, especially on higher portions. Yields of from 1 ton to 1½ tons of hay per acre are secured. Considering the difficulty of cultivating land of this character and the expense of underdrainage, it is believed that the soil can be used more profitable for hay and grazing than than for other purposes. Applications of lime would materially better the condition for most crops.

The native timber growth consisting largely of beech, sycamore and elm has been cleared away during the early settlement of the country.

The Moshannon bottom soils as a whole are valued at $100 an acre, but this soil if segregated would be valued at a much lower figure.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the erosion phase of the Moshannon clay:

Mechanical Analyses of Moshannon Clay, Erosion Phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
23702	Soil	0.3	2.2	2.7	5.6	1.6	46.3	41.1
23703	Subsoil .	.0	2.0	1.6	2.6	.7	45.7	47.3

Summary.

The Point Pleasant area comprises Mason, Jackson, and Putnam counties and covers an area of 1,274.86 square miles in southwestern West Virginia.

The elevation ranges from 500 feet to 1,400 feet above sea level. For the most part the upland is broken and rough with narrow valleys, but many flat-topped ridges are encountered and the valleys along the larger streams are comparatively broad. The Ohio river receives all the drainage from the western part of the area and the rest goes first into the Kanawha and then into the Ohio river

Most of the population is engaged in farming. There are no large manufacturing interests, and the mining is confined to a very small area.

The farms are usually small and operated to a large extent by the owners.

Farm labor is scarce, much labor being absorbed in the oil regions of adjoining counties. Most of the efficient labor has drifted to the oil fields in adjoining counties where much better prices are paid, ranging about $1 a day higher than upon the farms.

Point Pleasant, the principal town of the area and county seat of Mason county, has a population of about 3,000. Ravenswood and Ripley, in Jackson county; Winfield, Hurricane and Raymond City in Putnam; and Mason City in Mason county, are other small but important towns in the area.

The area is well supplied with transportation facilities, both rail and water. The principal market for farm produce is Pittsburgh, Pa. Wheeling, Parkersburg, Huntington, Charleston, West Virginia, and Gallipolis, Ohio, represent the smaller markets.

Climatic conditions are favorable to both stock raising and general farming.

Corn, wheat, tobacco, and hay are the staple crops of the area. Oats, buckwheat, sorghum and sweet potatoes are grown to a limited extent. Some truck is grown, mainly potatoes, tomatoes and melons, along the Ohio river terraces. Many beef cattle are raised, especially in the hill sections. Other kinds of stock are raised on a smaller scale. Dairying is not highly developed.

Apples are grown commercially to some extent and other fruits on a smaller scale for home consumption and local markets.

The area lies wholly within the Appalachian Plateau and is divided physiographically into upland, terrace and flood plains. The upland is represented by Meigs, Upshur, Dekalb and Brooke series and derived from the weathering in place of sandstones, sandy shales, red and gray shales of the Upper Coal Measures.

The alluvial soils of this area are more extensively de-

veloped than in any other area of West Virginia. The Wheeling, Tyler and Holston series are found upon the terraces. The Wheeling series is derived largely from glacial material, while the other terrace soils seem to be derived largely from Dekalb or closely associated material. The bottom land or flood plain is represented by the Huntington and Moshannon.

The Meigs clay loam is more extensive in area than any other type, but is less extensive than mapped in other areas of West Virginia. The type makes fair paying land and should be used almost exclusively for pasture.

The Upshur clay is very extensive and an important soil type. It is a limestone soil and makes excellent pastures. The more level areas and ridge type are cultivated and produce good crops of wheat and corn.

The Upshur silty clay loam covers a much smaller area than the clay. It is not quite as strong, but supports a good sod. It is easy to cultivate and is a good fruit soil.

The Brooke clay loam is the strongest upland soil in the area. It furnishes good grazing and produces good yields of hay, tobacco, wheat and corn. It is not adapted to fruit or truck.

The Dekalb soils are not naturally strong, but are easily handled and respond readily to fertilizers. They are good truck and fruit soils, especially the silt loam. Neither of the types furnish good pasture or mowing.

Rough strong land occurs in such small bodies that it has little effect upon the agriculture of the area.

The light types of the Wheeling series, sandy loam, fine sandy loam, fine sand, and gravelly loam are good truck soils and respond readily to proper management. The Wheeling silt loam is a strong type, well adapted to general market and heavy truck crops. It is the best potato soil in the area.

The Holston silt loam is a good truck and fruit soil and is also well adapted to general farm crops. It grows good apples and a fine grade of plug wrapper tobacco. It is easily built up and responds readily to good treatment.

The Tyler series, represented by the silt loam and silty clay loam are good grass soils and fairly well adapted to gen-

eral crops and fruit. They are difficult to handle, owing to their heavy texture and poor drainage.

The Moshannon silt loam is a strong soil type, producing heavy yields of corn and furnishing good pasture and mowings.

The Moshannon clay, erosion phase, produces good crops of wheat, corn and hay, but is difficult to handle. Some areas are best suited to pasture and hay production, and very little attempt is made to produce cultivated crops upon them. This soil includes some Holly loam.

The Huntington silt loam is best adapted to corn, and over half of its area is planted to that crop each season. In the southern part of the area tobacco is grown successfully.

Huntington loam is subject only to occasional overflow and is well suited to trucking and general farm crops.

CHAPTER XIII.

LEVELS ABOVE MEAN TIDE IN JACKSON-MASON-PUTNAM COUNTIES.

BALTIMORE & OHIO RAILWAY.

Ohio River Division (Elevation on Top of Rail).

Distances from Wheeling.	Stations.	State.	County.	Elevation.
93.6	Parkersburg (el'v'ted platform	W. Va.	Wood	624.0
96.6	Blennerhasset	W. Va.	Wood	...
99.7	Washington	W. Va.	Wood	636
101.6	Walker's Crossing	W. Va.	Wood	...
102.7	Nehldahls	W. Va.	Wood	599
105.1	New England	W. Va.	Wood	...
105.6	Lamps	W. Va.	Wood	...
107.3	Harris Ferry	W. Va.	Wood	595
109.6	Lee Creek	W. Va.	Wood	...
110.1	Humphrey	W. Va.	Wood	...
111.6	Belleville	W. Va.	Wood	590
114.9	Lone Cedar	W. Va.	Jackson	...
118.2	Marrayville	W. Va.	Jackson	591.0
120.1	Williams	W. Va.	Jackson	...
120.4	Polks	W. Va.	Jackson	...
106.0	Muses Bottom	W. Va.	Jackson	586
121.1	Coleman	W. Va.	Jackson	...
121.6	Morgan	W. Va.	Jackson	...
123.9	Portland	W. Va.	Jackson	...
124.8	Sherman	W. Va.	Jackson	586
127.1	Turkey Run	W. Va.	Jackson	...
128.2	Ravenswood	W. Va.	Jackson	584
128.8	R. S. & G. Junction.........	W. Va.	Jackson	581
132.1	Pleasant View	W. Va.	Jackson	578
135.3	Willow Grove	W. Va.	Jackson	582
138.6	Ripley Landing	W. Va.	Jackson	...
139.2	Milwood	W. Va.	Jackson	577
140.6	School House	W. Va.	Jackson	...
144.2	Letart	W. Va.	Mason	574
148.1	Antiquity	W. Va.	Mason	...
149.9	Graham	W. Va.	Mason	570
153.0	New Haven	W. Va.	Mason	575
154.8	Hartford	W. Va.	Mason	569
157.5	Mason City	W. Va.	Mason	573
154.2	Clifton	W. Va.	Mason	563
161.1	West Columbia	W. Va.	Mason	...

Distances from Wheeling.	Stations.	State.	County.	Elevation.
161.9	Spilman	W. Va.	Mason	567
164.3	Brownville	W. Va.	Mason	563
166.9	Mackers	W. Va.	Mason	575
169.3	Locust Lane	W. Va.	Mason	560
172.5	Point Pleasant	W. Va.	Mason	570
174.2	Henderson	W. Va.	Mason	563
178.1	Gallipolis Ferry	W. Va.	Mason	573
179.1	Beals' Siding	W. Va.	Mason	...
182.1	Elwell	W. Va.	Mason	...
184.0	Ben Lomond	W. Va.	Mason	552
185.1	Hogsett	W. Va.	Mason	...
187.5	Apple Grove	W. Va.	Mason	570
188.6	Mercer's Bottom	W. Va.	Mason	...
189.6	Ashton	W. Va.	Mason	...
192.5	Glenwood	W. Va.	Mason	550
194.1	Lasey's Lane	W. Va.	Mason	...

Ripley and Mill Creek Valley Branch O. R. R. R.

Distances from Milwood.	Stations.	State.	County.	Elevation.
0.0	Milwood	W. Va.	Jackson	577
3.0	Cotageville	W. Va.	Jackson	583
6.0	Angerona	W. Va.	Jackson	586
8.0	Evans	W. Va.	Jackson	601
13.0	Ripley	W. Va.	Jackson	599

Ravenswood, Spencer and Glenville Branch O. R. R. R.

Distances from Rav'nswood	Stations.	State.	County.	Elevation.
0.0	Ravenswood	W. Va.	Jackson	584
0.6	R. S. & G. Junction	W. Va.	Jackson	581
1.0	Bridgeport	W. Va.	Jackson	579
3.1	Silverton	W. Va.	Jackson	575
6.3	Crown Summit	W. Va.	Jackson	637
8.6	Sandyville	W. Va.	Jackson	592
12.2	Meadowdale	W. Va.	Jackson	611
14.3	Duncan	W. Va.	Jackson	626
15.1	Leroy	W. Va.	Jackson	635
17.0	Liverpool	W. Va.	Jackson	661
19.5	Sandy Summit	W. Va.	Roane	889
21.7	Seamans	W. Va.	Roane	695
22.2	Dukes	W. Va.	Roane	684
23.0	Reedy	W. Va.	Roane	669
27.0	Hardman	W. Va.	Roane	695
30.0	Barrs	W. Va.	Roane	899
33.0	Spencer	W. Va.	Roane	710

List of Levels and Distance Tables of

THE CHESAPEAKE & OHIO RAILWAY

From Charleston to Huntington.

Main Line Chesapeake & Ohio Railroad.

Miles from Ft. Monroe.	Stations.	State.	County.	Elevation.
453.6	Charleston	W. Va.	Kanawha	611
455.2	Elk	W. Va.	Kanawha	...
457.2	South Charleston	W. Va.	Kanawha	...
458.9	Spring Hill	W. Va.	Kanawha	605
465.5	St. Albans	W. Va.	Kanawha	600
466.9	Lewis	W. Va.	Kanawha	...
469.6	Scary	W. Va.	Putnam	...
473.2	Scott	W. Va.	Putnam	713
475.1	Teays	W. Va.	Putnam	...
479.2	Hurricane	W. Va.	Putnam	700
481.5	Culloden	W. Va.	Cabell	...
485.8	Milton	W. Va.	Cabell	...
490.3	Ona	W. Va.	Cabell	586
491.9	Blue Sulphur Springs.......	W. Va.	Cabell	...
494.7	Barboursville	W. Va.	Cabell	586
498.2	Wilson	W. Va.	Cabell	...
501.0	Guyandot	W. Va.	Cabell	586
501.2	D. K. Cabin	W. Va.	Cabell	575
502.4	Huntington Shops	W. Va.	Cabell	575
504.0	Huntington	W. Va.	Cabell	575

The following is copied from Bulletin No. 2, pages 61-65, West Virginia Geological Survey:

KANAWHA & MICHIGAN RAILWAY.

"The Kanawha & Michigan Railway is a line which connects with the Chesapeake & Ohio Railway at Gauley Bridge on New river, and extending northwestward down the east bank of the Great Kanawha river through Charleston, the State Capital, reaches the Ohio river at Point Pleasant. where crossing the same on a high bridge and extending northward, it connects at Corning, Ohio, with the Toledo & Ohio Central lines for the lake region. The control of the Kanawha & Michigan Railway has recently been transferred to the Chesapeake & Ohio system and allied interests, so that after the legal

phases of the matter have been arranged, it will provide the Chesapeake & Ohio with what it has long desired: viz., a direct outlet for its coal tonnage from the Kanawha and New river regions to the lakes. This line also gets a large tonnage of coal and other freights from the Coal & Coke Railway and the Kanawha & West Virginia, both of which connect with its lines at Charleston.

"Since no connected profile of this Kanawha & Michigan Railway, and its connections through to Toledo had ever been published, the State Geologist requested the Chief Engineer of the same, Mr. Clifford Buxton, of Toledo, Ohio, to prepare such a table for publication, and this he very kindly consented to do and transmitted it, together with the following explanatory letter:

OHIO CENTRAL LINES.

Office of Chief Engineer.

Toledo & Ohio Central Railway Co.
Kanawha & Michigan Railway Co.
Clifford Buxton, Chief Engineer.

Toledo, O., April 23, 1908.

Dr. I. C. White, State Geologist,
Morgantown, W. Va.

Dear Sir:

As per your request of April 13th, I send you herewith a table showing distances and elevations between Toledo and Ohio river; also return the copy of table sent by you with a few minor corrections.

"There are two lines of Toledo & Ohio Central from a point (Whitmore) near Toledo to Thurston. Distances as shown south of Thurston are by the long line i. e.: via Columbus.

"These elevations are above sea level as accurately as I have been able to establish them, and are referred to an entirely different datum from the elevations given for West Virginia. The line from Hobson to Kanauga is operated over a leased track, and I have no data concerning it except distances.

"Elevations at points left blank in your table are not at

hand; hence I have been unable to supply them, but the variation from point to point is, you will note, very slight so that their omission will not be a serious matter."

Yours truly,

(Signed) C. BUXTON, Chief Engineer.

Kanawha & Michigan Railway.

Distances from Toledo.	Stations.	State.	County.	Elevation.
0.0	Toledo	Ohio	Lucas	581.86
1.6	Fassette St.	Ohio	Lucas	615.06
2.7	Whitmore	Ohio	Wood	612.36
5.0	Hobart	Ohio	Wood	625.26
8.8	Lime City	Ohio	Wood	643.96
13.2	Dowling	Ohio	Wood	662.56
14.6	Dunbridge	Ohio	Wood	663.66
16.8	Sugar Ridge	Ohio	Wood	670.16
20.7	Bowling Green	Ohio	Wood	696.16
24.0	Portage	Ohio	Wood	683.56
26.1	Mermill	Ohio	Wood	683.46
27.8	Mungen	Ohio	Wood	687.76
29.0	Trombley	Ohio	Wood	694.86
30.0	Cygnet	Ohio	Wood	704.36
34.3	Galates	Ohio	Wood	730.66
37.0	Van Buren	Ohio	Hancock	776.76
38.9	Mortimer	Ohio	Hancock	808.86
44.1	Findlay	Ohio	Hancock	775.56
54.1	Arlington	Ohio	Hancock	864.56
58.1	Williamstown	Ohio	Hancock	934.56
61.3	Dunkirk	Ohio	Hardin	950.66
65.2	Blanchard	Ohio	Hardin	951.76
72.2	Kenton	Ohio	Hardin	965.56
81.5	Ridgeway	Ohio	Hardin	1052.36
85.8	Horton	Ohio	Logan	1076.76
89.7	West Mansfield	Ohio	Logan	1084.50
92.5	Lunda	Ohio	Union	1102.76
95.7	Raymonds	Ohio	Union	1063.26
97.5	Peoria	Ohio	Union	1052.46
100.5	Marysville	Ohio	Union	992.86
113.6	Arnold	Ohio	Union	965.16
117.0	Kile	Ohio	Union	951.06
119.5	Amlin	Ohio	Franklin	945.56
122.0	Hilliards	Ohio	Franklin	920.76
130.7	West Columbus	Ohio	Franklin	719.36
132.2	Columbus	Ohio	Franklin	716.56
135.1	South Columbus	Ohio	Franklin	744.56
141.2	Truro	Ohio	Franklin	771.56
144.2	Brice	Ohio	Franklin	784.26
149.0	Pickerington	Ohio	Fairfield	841.16
153.2	Harley	Ohio	Fairfield	873.16
157.2	Basil	Ohio	Fairfield	868.26
157.8	Baltimore	Ohio	Fairfield	869.86
160.8	Thurston	Ohio	Fairfield	879.56

Distances from Toledo.	Stations.	State.	County.	Elevation.
6.7	Moline	Ohio	Wood	672.26
10.0	Stony Ridge	Ohio	Wood	647.36
14.3	Luckey	Ohio	Wood	671.66
17.3	Pemberville	Ohio	Wood	656.66
21.3	Woodside	Ohio	Wood	672.36
24.8	Prairie Depot	Ohio	Wood	697.46
28.3	Hatton	Ohio	Wood	715.36
35.5	Fostoria	Ohio	Seneca	771.36
44.3	New Regal	Ohio	Seneca	822.86
46.3	Berwick	Ohio	Seneca	842.86
49.4	McCutchenville	Ohio	Seneca	802.66
55.0	Sycamore	Ohio	Wyandot	853.36
57.5	Duenquadt	Ohio	Wyandot	906.56
60.5	Lemart	Ohio	Crawford	975.86
63.9	Spore	Ohio	Crawford	886.26
69.5	Bucyrus	Ohio	Crawford	1004.46
76.0	New Winchester	Ohio	Crawford	1025.06
79.4	Martel	Ohio	Marion	1041.86
82.4	Climax	Ohio	Morrow	1035.36
87.4	Edison	Ohio	Morrow	1061.46
88.7	Mt. Gilead	Ohio	Morrow	1093.86
94.8	Fulton	Ohio	Morrow	1111.86
99.1	Marengo	Ohio	Morrow	1125.56
103.4	Peerless	Ohio	Delaware	1184.56
106.0	Rich Hill	Ohio	Knox	1218.76
108.3	Centerburg	Ohio	Knox	1195.76
112.7	Croton	Ohio	Licking	1166.66
118.5	Johnstown	Ohio	Licking	1165.16
124.8	Alexandria	Ohio	Licking	957.56
126.9	Clemons	Ohio	Licking	925.46
129.7	Granville	Ohio	Licking	912.06
133.4	Central City	Ohio	Licking	888.26
138.6	Hebron	Ohio	Licking	892.06
142.1	Lakeside Park	Ohio	Fairfield	891.26
133.7	Millersport	Ohio	Fairfield	912.26
147.9	Thurston	Ohio	Fairfield	879.56
163.5	Pleasantville	Ohio	Fairfield	910.46
169.3	Rushville	Ohio	Fairfield	863.46
173.8	Bremen	Ohio	Fairfield	800.66
180.7	Junction City	Ohio	Perry	...
185.2	New Lexington	Ohio	Perry	861.16
192.0	Moxahala	Ohio	Perry	828.66
196.1	Rendville	Ohio	Perry	748.66
197.4	Corning	Ohio	Perry	728.96
201.7	Burr Oak	Ohio	Athens	699.76
202.3	Palos	Ohio	Athens	698.66
205.4	Glouster	Ohio	Athens	687.16
206.2	Trimble	Ohio	Athens	678.56
207.3	Jacksonville	Ohio	Athens	680.96
211.3	Millfield	Ohio	Athens	674.06
214.2	Chauncey	Ohio	Athens	657.56
218.7	Armitage	Ohio	Athens	653.66
220.5	Grosvenor	Ohio	Athens	654.76
224.8	Fisher	Ohio	Athens	663.36
227.1	Hebbardsville	Ohio	Athens	679.76

Distances from Toledo.	Stations.	State.	County.	Elevation.
230.0	Albany	Ohio	Athens	746.02
235.0	Carpenter	Ohio	Meigs	628.16
238.5	Dyesville	Ohio	Meigs	610.26
241.7	Dexter	Ohio	Meigs	606.56
245.7	Langsville	Ohio	Meigs	579.76
248.9	Rutland	Ohio	Meigs	577.56
250.4	Noble Summit	Ohio	Meigs	641.36
254.5	Hobson	Ohio	Meigs	571.36
257.0	Cheshire	Ohio	Gallia	...
262.4	Addison	Ohio	Gallia	...
265.2	Kanauga	Ohio	Gallia	...
266.5	Point Pleasant	W. Va.	Mason	579.5
271.8	Wagner	W. Va.	Mason	556.5
271.8	Brosia	W. Va.	Mason	562.8
275.8	Beech Hill	W. Va.	Mason	561.6
278.2	Leon	W. Va.	Mason	565.9
...	Kings	W. Va.	Mason	...
280.8	Arbuckle	W. Va.	Mason	570.2
...	Armstrong	W. Va.	Mason	...
283.4	Grim	W. Va.	Mason	561.0
284.7	Robertsburg	W. Va.	Putnam	564.0
288.1	Buffalo	W. Va.	Putnam	567.0
291.4	Woods	W. Va.	Putnam	573.0
292.9	Rumer	W. Va.	Putnam	567.0
297.4	Red House	W. Va.	Putnam	577.0
...	Leach	W. Va.	Putnam	...
...	Courtney	W. Va.	Putnam	578.6
301.2	Plymouth	W. Va.	Putnam	575.0
302.4	Black Betsey	W. Va.	Putnam	579.0
304.0	Raymond City	W. Va.	Putnam	596.1
305.0	Poca	W. Va.	Putnam	...
...	Putnam	W. Va.	Putnam	581.8
309.3	Lock Seven	W. Va.	Kanawha	587.6
311.1	Sattee	W. Va.	Kanawha	586.1
314.4	Institute	W. Va.	Kanawha	...
314.8	Farm	W. Va.	Kanawha	587.9
316.7	Dunbar	W. Va.	Kanawha	...
...	Rochelle	W. Va.	Kanawha	...
318.6	Mound	W. Va.	Kanawha	591.0
...	Sheldon	W. Va.	Kanawha	...
321.0	West Charleston	W. Va.	Kanawha	597.1
322.3	Park Street	W. Va.	Kanawha	598.8
323.4	Charleston	W. Va.	Kanawha	592.1
324.3	Elizabeth Street	W. Va.	Kanawha	...
326.5	Snow Hill	W. Va.	Kanawha	603.0
328.5	Dana	W. Va.	Kanawha	...
329.6	Malden	W. Va.	Kanawha	...
...	Furnace	W. Va.	Kanawha	...
331.3	Heskett	W. Va.	Kanawha	...
333.7	Piatt	W. Va.	Kanawha	604.1
335.2	Belle	W. Va.	Kanawha	...
336.6	Witcher	W. Va.	Kanawha	...
337.2	Dickinson	W. Va.	Kanawha	626.0
339.5	Shrewsberry	W. Va.	Kanawha	610.8

Distances from Toledo.	Stations.	State.	County.	Elevation.
340.3	Monarch	W. Va.	Kanawha	614.0
341.6	Cedar Grove	W. Va.	Kanawha	618.0
343.7	Riverside	W. Va.	Kanawha	...
345.2	Hugheston	W. Va.	Kanawha	...
346.6	London	W. Va.	Kanawha	631.0
349.8	Cannelton	W. Va.	Kanawha	632.0
350.4	Smithers	W. Va.	Fayette	632.0
351.2	Longacre	W. Va.	Fayette	...
352.4	Harewood	W. Va.	Fayette	...
352.8	Boomer	W. Va.	Fayette	651.5
355.5	Falls View	W. Va.	Fayette	...
359.1	Glen Ferris	W. Va.	Fayette	657.3
360.6	Gauley Bridge	W. Va.	Fayette	671.4

ELEVATION ABOVE TIDE IN JACKSON-MASON-PUTNAM COUNTIES.

Determined by United States Geological Survey.

The following elevations of the United States Geological Survey determined and marked in Jackson-Mason-Putnam counties are taken from Bulletin No. 2, page 155, of the West Virginia Geological Survey. Dr. I. C. White has the following to say in regard to the value of these levels:

"The topographic branch of the United States Geological Survey, in connection with and aided by the United States Coast and Geodetic Survey, is covering the entire United States with a net work of precise elevations. As the result of precise leveling, many of the old levels and bench marks accepted for many years as accurate by the railroad officials, civil engineers, and others, have been proven erroneous, often to the extent of several feet. In this readjustment of elevations the United States Geological Survey finds it necessary to change slightly, as a higher degree of accuracy is attained, some of its own former standard elevations, and thus those given of the same bench mark for one year may differ slightly from those given in a later publication. The railroad, civil and mining engineers are now almost universally adjusting their levels to those given by the United States Geological Survey, especially since the recent plan has been adopted of placing bronze tablets marked with the elevations in conspicuous positions every few miles in each quadrangle surveyed."

RAVENSWOOD EAST ALONG RAVENSWOOD, SPENCER & GLENVILLE RAILROAD, TO DUKES.

(Double Rodded Line).

Silverton, 0.5 miles west of, 2.5 miles east of Ravenswood, north side of track, in ledge of rock; bronze tablet stamped "579 ADJ 1903" 579.241
Silverton, at road crossing; top of rail........................584.9
Crow Summit, 0.5 miles west of, 2.7 miles east of Silverton, east of and near a large hill, 9 feet left of center of tract, in top of large stone; bronze tablet stamped " 591 ADJ 1903"....590.973
Crow Summit, in front of station; top of rail.................640.9
Sandyville, road crossing; top of rail........................598.80
Sandyville, 1 mile east of, near road crossing, on right of track in northwest corner of northwest abutment of iron county bridge; bronze tablet stamped 594 ADJ 1903"............593.678
Jones Crossing; top of rail....................................602.6
Meadowdale, 300 feet northwest of station, near junction of Big Lick road with pike, in face of large rock; bronze tablet stamped "626 ADJ 1903"...................................626.042
Meadowdale, at road crossing; top of rail.....................817.2
Leroy, store and post-office, about 300 feet southwest and across Sand Creek, in face of outcrop of rock; bronze tablet stamped "646 ADJ 1903"...................................646.038
Liverpool, 1.6 miles east of, northwest side of county road, about 220 feet northeeast of railroad crossing; in outcrop of rock bronze tablet stamped "873 ADJ 1903"....................873.010

Wiseburg Southwest Along Highway, to Sherman.

Cuba, 300 feet north of post-office, on west (opposite) side of road, edge of stream, in top of large boulder; aluminum tablet stamped "673 GRAFTON 1903"....................673.122

Evans East Along Railroad and Turnpike, to Point 0.5 Miles East of Marshall.

Ripley, 2.9 miles west of, 70 feet south of track, east side of road, in top of low rock; bronze tablet stamped "602 ADJ 1903" 601.621
Ripley, railroad crossing at station; top of rail..............606.0
Ripley, Courthouse square, southwest corner, in top of stone post; bronze meridian tablet stamped "615 ADJ 1903"....614.566
Hereford, 3.4 miles west of, north of road and near sharp bend to south, in shelf of rock; bronze tablet stamped "824 ADJ 1903" 823.894
Hereford, 0.3 miles east of, north of road, in top of large rock; bronze tablet stamped "632 ADJ 1903"..................631.750
Frozen Camp, in north end of west abutment of covered bridge over Big Run; bronze tablet stamped "641 ADJ 1903"....641.091
Marshall, 0.5 mile east of, north of road, in face of large rock; bronze tablet stamped "697 ADJ 1903"..................696.931

Ripley North Along Road, to Sandyville.

Ripley, 3.25 miles north of, 0.4 mile south of crossroad and summit, east of road, in top of outcrop of rock; bronze tablet stamped "729 ADJ 1903"..................................728.595

Mentor, 1.4 miles north of, in second step at northeast side of northwest abutment of covered bridge over Sand Fork; bronze tablet stamped "591 ADJ 1903"..................591.050

Leroy Northeast Along Road, to Pewee.

Leroy, 2.65 miles north of, east of road, near dwelling, in shelf of outcrop of rock; bronze tablet stamped "961 ADJ 1903"..961.200

Pewee post-office, 0.47 mile northeast of, north of road, in face of ledge of rock; bronze tablet stamped "692 ADJ 1903"...692.156

Kenna and Winfield Quadrangles.

Elevations based upon the 1903 adjustment of precise leveling.

Level on Winfield quadrangle in 1906 by C. H. Burns, and on Kenna quadrangle by Burns and E. S. Dawson in 1906.

KENNA QUADRANGLE.

Harmony West Along Road to Kenna, Thence Southwest, to Mouth of Stumpy Run 4.4 Miles West of Liberty.

Harmony, 1.2 miles west of, 200 feet west of mouth of Wolf Camp Run, at road forks, 60 feet north of road, in side of field on property of T. W. Hughes, in front of house on south of road in sandstone outcrop; aluminum tablet; stamped "746"..746.533

Higby post-office, 1.5 miles southeast of, south of road and bank of Higby Creek, 750 feet above right fork of Higby Creek, in sandstone; aluminum tablet stamped "738"...........737.812

Belgrove, 1 mile southeast of, on north side of road, on bank 70 feet east of private road up deep hollow to north of house and blacksmith shop in sandstone outcrop; aluminum tablet stamped "704"..703.367

Belgrove, 2 miles west of, 40 feet south of center of road in field, 60 feet north of house, in sandstone outcrop; aluminum tablet stamped "817"..............................816.152

Kenna, 1.5 miles east of, north of road, 700 feet west of schoolhouse, 380 feet east of road fork to north, in sandstone outcrop; aluminum tablet stamped "747"................746.350

Emma, west of road, in cornerstone of church; aluminum tablet stamped "980"..979.454

Liberty, in stone wall of cellar (property of J. M. Carney) on west side, 100 feet from center of road, opposite post-office; aluminum tablet stamped "779"....................777.937

Kettle West Along Road, to Near Sissonville, Thence Northwest, to Kenna.

Ireland post-office, 0.2 mile east of, north of road, 40 feet north of Pocatalico River, 30 feet west of Camp School in rock; aluminum tablet stamped "656"...............655.797

Ireland, 3.1 miles southeast of, 50 feet west of Pocatalico River, 0.2 mile north of Emma Bell schoolhouse, east of road, in sandstone outcrop; aluminum tablet stamped "646"......645.376

Carney post-office, 0.5 mile west of, north of road, 150 feet north of Pocatalico River, 0.1 mile west of Victory schoolhouse, in rock boulder; aluminum tablet stamped "635"....635.055

Sissonville, 3 miles northwest of post-office, in south end of east abutment of iron bridge over left hand of Pocatalico River; aluminum tablet stamped "625"..................625.393

Loop post-office, 265 feet northwest of, 100 feet west of mouth of Dudden Creek, 1 mile southeast of Coldtown, in east end f north abutment of iron bridge; aluminum tablet stamped "643"..643.148

Goldtown, 0.5 mile north of, east of road, 40 feet from center of road, road forks to east, in sandstone foundation of Watts Chapel; aluminum tablet stamped "671"...........670.471

Kena, 0.8 mile south of, east of road, 380 feet south of house to west, in sandstone outcrop; aluminum tablet stamped "872" 871.772

SISSONVILLE SOUTHWEST 3.4 MILES.

(Single Spur Line).

Sissonville, 90 feet south of, north end west side of iron bridge over Pocatalico River; aluminum tablet stamped "624"....624.086

Sissonville, 3.45 miles southwest of, 50 feet west of road, 100 feet west of Pocatalico River, 0.9 mile north of Derrick Creek, in garden of old house, in rock boulder; aluminum tablet stamped "615"..................................615.245

WINFIELD QUADRANGLE.

Leon South Along East Side of Great Kanawha River, to Woods Station, Thence Across River and West to Albatross.

Arbuckle, 0.1 mile south of, 10 feet east of road, in sandstone; aluminum tablet stamped "608"......................608.410

Arbuckle, 2.3 miles south of, in bridge abutment on northeast corner of bridge over Arbuckle Creek; aluminum tablet stamped "567"..567.040

Buffalo, in stone door sill in west end of M. E. Church (south); aluminum tablet stamped "580"..........................579.846

Woods station, 3.8 miles south of Buffalo, east of road opposite fork west of Kanawha River ford to Fraziers bottom, in sandstone; aluminum tablet stamped "590"................590.290

Woods Station South Along Kanawha River, to Red House Shoals, Thence East Along Highway, to Paradise, Thence North to Elmwood, Thence West to Grimms' Landing.

Redhouse (Shoals post-office), in northeast end of county bridge abutment; aluminum tablet stamped "570"................569.670
Redhouse, 3.5 miles east of, 0.4 mile west of a road summit, 20 feet south of center of road, in sandstone; aluminum tablet stamped "967"....................................966.730
Confidence, 0.8 mile east of, 15 feet north of center of road, in sandstone; aluminum tablet stamped "853"...........853.331
Paradise, 2.3 miles north of, east side of road at crossroads, north of South Fork (Cherry Fork) of Eighteen Mile Creek, in sandstone; aluminum tablet stamped "660"...........659.852
Paradise, 4.5 miles north of, in abutment of south end of county bridge over north fork of Eighteen Mile Creek; aluminum tablet stamped "635"...............................634.661
Tipple, 2.2 miles south of, 15 feet north from center of road, south of house, hollow north and south, in sandstone; aluminum tablet stamped "713"..........................713.223
Elmwood post-office, 0.7 mile east of, on northeast corner of road forks in sandstone; aluminum tablet stamped "624"..625.549
Grimms Landing, 3 miles east of, north of road, south of house, in sandstone; aluminum tablet stamped "624"..........625.868

ST. ALBANS QUADRANGLE.

Poca South Along Kanawha & Michigan Railway, to St. Albans.

Poca Station, 300 feet south of, in west side of south abutment of highway bridge over Correly Branch; copper bolt stamped "672-C".......................................572.341
Lock No. 7, top of coping (equals 555.50 U. S. engineer elevation) 559.355
St. Albans, located in fence line on west side of First street, 60 feet north of north rail of Chesapeake and Ohio Railway track, in center of west base monument, in top of limestone post projecting one foot above ground; copper bolt (elevation is given as 594.78 by the Coast and Geodetic Survey) 594.691

St. Albans, Northwest Along Chesapeake & Ohio Railroad, to Scott Station.

St. Albans, in front of station; top of rail......................596.4
Scott, 75 feet south of station, in Pine's orchard, 50 feet south of Chesapeake and Ohio tracks; iron post stamped "693-C".692.856

St. Albans, West, via Tackett Creek, to Young's Store; Thence South to Garrett's Bend; Thence Northeast to St. Albans.

St. Albans, 5.0 miles west of, south of road, first house south of Young's store belonging to John Hodges, in east chimney 6 feet from ground; copper bolt stamped "U. S. G. S.-737".737.294

Garretts Bend, 2 miles north of, Trace Fork of Mud River, 200 feet below mouth of Two Mile Branch, 400 feet northwest of Anderson McAllister's house, north side of stream, in huge rock; corner bolt stamped "U. S. G. S.-669"..........669.125

Tornado, 1.5 miles southwest of, on road up Falls Creek, on south side of road, 150 feet above the first crossing of Falls Creek; iron post stamped "614"....................613.708

GLENWOOD, KENO, PT. PLEASANT AND RAVENSWOOD QUADRANGLES.

Cabell, Jackson, Mason and Putnam Counties.

Elevations based upon the 1903 adjustment of precise leveling.

Leveling on Keno quadrangle in 1904 by F. W. Hughes; and on Glenwood, Point Pleasant and Ravenswood quadrangles in 1905 by G. L. Gordon.

KENO QUADRANGLE.

Set From Army Engineer's Bench Mark "211-A."

Brewester (formerly Williams), 450 feet north of station, in top of Ohio River railroad culvert over Williams Run, 28 feet west of center of tract, 7 feet south of northwest corner of culvert; aluminum tablet stamped "589 ADJ 1903"..581.340

POINT PLEASANT QUADRANGLE.

Gallipolis, Ohio Crossing by Reciprocal Readings, to West Virginia; Thence Along Ohio Railroad, to Elwell.

Gallipolis Station, W. Va., 1 mile south of Baltimore and Ohio Railroad open culvert, in top of southwest corner; aluminum tablet stamped "582 ADJ 1903"......................581.765

Point Pleasant North Along Ohio River Railroad, to West Columbia, Thence East by Road, to Locust Grove School House.

Point Pleasant, W. Va., on top of stone foundation northwest corner of Mason County courthouse; chiseled square and letters U. S. B. M. (U. S. engineer's bench mark "264-A")..569.049
Point Pleasant, W. Va., west side of "Cornstalk Monument" in Mason County courthouse yard; bronze tablet stamped "570" 569.431
Point Pleasant, Lock No. 11, zero of gauge 513.94
Linn Station, Mr. Hogg's brick house, at northwest corner of top stone of foundation northwest face; bronze tablet stamped "586 ADJ 1903"....................................586.084
Maggie, railroad bridge over small run, south abutment, west end; bronze tablet stamped "569 ADJ 1903"..............568734
Spilman, 0.2 mile east of south of track, in south face of outcrop of rock; bronze tablet stamped "576 ADJ 1903".....576.008
West Columbia, 2.4 miles east of, on left side of Ten Mile Run, opposite Locust schoolhouse, in shelf of rock cliff; bronze tablet stamped "603 ADJ 1903"..........................603.406

Derby Along Kanawha & Michigan Railroad Northwest, to Point Pleasant.

Ambrosia, road crossing; top of rail..........................566.6
Ambrosia, 0.1 mile north of, east of road, 30 feet south of end of covered bridge over Rock Castle Creek, in shelf of rock; bronze tablet stamped "577 ADJ 1903"..............576.792
Ambrosia, 2.5 miles northwest of, iron bridge over Three Mile Creek, southeast pier, south corner of bridge seat; bronze tablet stamped "554 ADJ 1903"..........................553.645

GLENWOOD QUADRANGLE.

Elwell South Along Ohio River Railroad, to Glenwood.

Elwell, road crossing; top of rail.............................560.2
Ben Lomond, road crossing; top of rail........................559.2
Ben Lomond, 0.2 mile south of, railroad bridge No. 1841 north abutment, east of track; aluminum tablet stamped "557 ADJ 1903" 557.245
Apple Grove Station, 570 feet north of, top of west end of railroad culvert; aluminum tablet stamped "579 ADJ 1903"...578.864
Apple Grove, road crossing; top of rail....................578.1
Ashton, road crossing; top of rail............................561.9
Ashton, 0.86 mile southwest of, 150 feet northeast of trestle over Eighteen Mile Creek, 10 feet east of track, squared stone foundation of water tank, in top of; aluminum tablet stamped "561 ADJ 1903"...................................561.071
Glenwood, 2250 feet north of upper landing, 236 feet south of U. S. post light at foot of straight Ripple, 125 feet north of mouth of Gwyno Run, on boulder 15x10x4 feet high; chiseled square (U. S. engineer's bench mark No. 284")..........517.797

Glenwood, road crossing; top of rail........................558.8
Glenwood bridge over small run, southwest abutment north end of bridge seat; aluminum tablet stamped "544 ADJ 1903"..543.775

Glenwood South Along Highway, to Swann: Thence Northeast, to Albatross: Thence North to Derby.

Glenwood, 2.84 miles south of, east of road, in face of rock outcrop, aluminum tablet stamped "592 ADJ 1903"........591.944
Glenwood, 5.9 miles south of, west of road, in face of rocky cliff; aluminum tablet stamped "587 ADJ 1903".........587.029
Swann post-office, 0.1 mile north of, near church at northeast angle of forks of roads, under chestnut tree, on top of large stone; chiseled square...........................830.158
Swann, 2.3 miles east of, north of road, in face of rock ledge; aluminum tablet stamped "577 ADJ 1903".................577.045
Bryan, 0.6 mile northeast of, north of road, east end of face of rock cliff; aluminum tablet stamped "837 ADJ 1903"......837.152
Ellen, 2.1 miles east of, northwest of road, in shelf of outcrop of rock; aluminum tablet stamped "638 ADJ 1903".......638.021
Albatross, 0.8 mile northeast of, between road and run, in top of large rock; aluminum tablet stamped "701 ADJ 1903"..701.068
Albatross, 2.5 miles northeast of, Riverview schoolhouse, north corner stone, center of northeast face of; aluminum tablet stamped "936 ADJ 1903"................................936.106
Albatross, 6.7 miles northeast of, 300 feet northeast of saddle of ridge, west of road, in face of outcrop of rock; aluminum tablet stamped "846 ADJ 1903"........................846.105
Siloam, 1.7 miles northeast of, bend of road to right on east side, in top of large stone; aluminum tablet stamped "660 ADJ 1903"..660.014
Flaxton, 0.11 mile north of, east of road, in shelf of outcrop of rock; aluminum tablet stamped "856 ADJ 1903"..........856.092
Flaxton, 2.0 miles north of, north of road and creek at crossing of Nine Mile Creek, in outcrop of rock; aluminum tablet stamped "638 ADJ 1903"................................638.335

RAVENSWOOD QUADRANGLE.

At Sherman.

Sherman, near Ohio River railroad station on northwest pier of railroad bridge over Little Sandy Creek; chiseled square (army engineer's bench mark "216-A")...................587.823
Sherman, 150 feet south of station, in north pier of Ohio River railroad bridge, northeast corner of coping; aluminum tablet stamped "589 ADJ 1903"........................588.681

At Ravenswood.

Ravenswood, top of northwest corner of north pier of Ohio River railroad bridge No. 128.4 over Big Sandy Creek; chiseled square (army engineer's bench mark "219-A")..585.617

Milwood Along Ohio River Railroad, to Graham Station; Thence West Along Highways, to Locust Grove School House.

Milwood, on northeast corner of capstone of east pier of Ohio River railroad bridge over Little Mill Creek, 9.5 feet west of center of track, 1 foot south by 1 foot east of northeast corner of pier; chiseled square marked "U. S. B. M." (army engineer's bench mark No. "230-A")..............577.868
Milwood, Ohio River railroad bridge, east pier at south end; aluminum tablet stamped "578 ADJ 1903"...............577.879
Letart, 0.9 mile southeast of, county bridge over Tomlinson's Run; in east end of northwest pier; bronze tablet stamped "569 ADJ 1903"..569.505
Letart, in front of station; top of rail......................580.6
Graham Station, 4.13 miles southeast of, dwelling on right, 15 feet west of track, in shelf of outcrop of rock; bronze tablet stamped "581 ADJ 1903"........................581.207
Graham Station, road crossing; top of rail....................579.4
Graham, 0.4 mile west of, south of road, northeast of John Spencer's house, in shelf of rock; bronze tablet stamped "651 ADJ 1903"..651.009
Graham, 3.3 miles west of, west side of Union Church, 8 feet north of southwest corner, in stone foundation; bronze tablet stamped "681 ADJ 1903"........................681.177

Milwood Southeast Along Ripley & Mill Creek Valley Railroad, to Evans.

Angerona, 2.95 miles west of, south of track, 30 feet east of trestle over small run, in shelf of outcrop of rock; aluminum tablet stamped "589 ADJ 1903"...................588.590
Angerona, road crossing near station; top of rail.............583.1
Evans, 1.1 mile west of, two schoolhouses, northeast corner stone of one nearest track, in north face; bronze tablet stamped "642 ADJ 1903"...............................641.578
Evans, in front of station; top of rail......................606.5

Evans West Along Highway, to Rollins; Thence South, to Leon; Thence West to Derby.

Evans, 2.4 miles southwest of, in southeast angle of forks of roads; iron post stamped "930 ADJ 1903"................929.935
Evans, 5.6 miles southwest of, west of road, at foot of steep grade, in top of low outcrop of rock; bronze tablet stamped "921 ADJ 1903"..920.767
Baden, 0.09 mile northeast of, northeast of road, in outcrop of rock; bronze tablet stamped "968 ADJ 1905".............967.737
Rollins, triangle at crossroads at Big Run, in top of long stone planted 3 feet in ground; bronze tablet stamped "626 ADJ 1903" 625.758

Rollins, 3.3 miles south of, 0.2 mile north of road forks; northwest of road, south end of ledge of rock in top; bronze tablet stamped "665 ADJ 1903"..........................664.870
Leon, bridge over Thirteen Mile Creek near mouth, north abutment, in west end of bridge seat; bronze tablet stamped "559 ADJ 1903"..............................558.863
Derby post-office, near Beech Hill station, railroad crossing; top of rail...567.0
Beech Hill station, in front of, opposite side of track, in west face of outcrop of rock; aluminum tablet stamped "572 ADJ 1903"..571.528

MILTON QUADRANGLE.

Hurricane South, to Nye, Thence Southwest, to Hamlin, Thence Northwest, to Sarah.

Nye, in top stone of northwest pier of county bridge over Trace Fork of Mud River; bronze tablet stamped "625 GRAFTON" 623.468
Hamlin, in third stone from top in northeast end of abutment wall of bridge over Mud River; bronze tablet stamped "645 GRAFTON"..642.516
Salt Rock, in third stone from top in northeast end of retaining wall of highway bridge over Guyandotte River; bronze tablet stamped "586 GRAFTON"..........................583.536

LEVELS AND DISTANCE TABLES FOR THE GOVERNMENT LOCKS AND DAMS ON WEST VIRGINIA RIVERS*.

"The main rivers of the State draining the western slopes of the Alleghany mountains have been improved for navigation by systems of Locks and Dams built and cared for by the Federal Government. The levels and distance tables on these streams are here given for the first time in the Survey publications through the courtesies of the War Department engineers in charge of these improvements.

OHIO RIVER LOCKS AND DAMS.

"The United States Engineers, under the authority of Congress, many years ago, began the improvement of the Ohio river by building movable dams. The first of these to be con-

West Virginia Geological Survey Bulletin Two, pp. 203-206.

structed was the Davis Island Dam, a short distant below Pittsburgh. This one proved of so much value to navigation that other dams of like character have been authorized from time to time, until at the last session of Congress, the improvement of the entire Ohio river from Pittsburgh to Cairo was authorized.

"The tidal elevations and distance of each lock in the series from Lock No. 7 at Georgetown, Pennsylvania, to just below the mouth of the Big Sandy river, or along the entire length of the Ohio river in West Virginia, was kindly prepared for the Survey by Captain F. W. Altstaetter, Corps of United States Engineers, Wheeling, West Virginia, and transmitted with the accompanying letter as follows:

UNITED STATES ENGINEER'S OFFICE.

Post Office Box 75.

Wheeling, W. Va., July 27, 1910.

Dr. I. C. Whte, State Geologist,
Morgantown, W. Va.

Dear Sir:

1. I am in receipt of your letter of July 26, 1910, and also of topographic maps of the Ohio river counties, for which please accept my thanks.

2. I am enclosing herewith a table of the dams of the Ohio river from No. 7 to No. 27, which is just below Kenova.

Very respectfully,

(Signed) F. W. ALTSTAETTER,
Captain, Corps of Engineers.

LOCATION OF DAMS AND ELEVATIONS OF LOCK WALLS, OHIO RIVER.

(Elevations are referred to mean sea level—Sandy Hook, New Jersey, datum).

Dam No.	Distance below "Point Bridge" Pittsburg	Elevation of crest of Dam	Elevation of top of Abutment	Side of River for Lock	Location
1	4.7	703.000		Right	Davis Island.
2	9.0	699.875		Left	Merriman Bar.
3	10.0	692.134		Right	Sewickley, Pa.
4	18.6	684.393		Right	Economy, Pa.
5	23.9	676.752		Right	Freedom, Pa.
6	28.8	668.264		Right	Beaver, Pa.
		Elevation of top of land wall.			
7	36.9	667.6	664.6	Left	Georgetown, Pa. (Not yet built.)
8	46.1	660.7	657.7	W. Va.	Congo, W. Va.
9	55.6	654.3	651.3	W. Va.	New Cumberland, W. Va. (Not yet built.)
10	65.7	646.9	643.9	Ohio	Stubenville, O. (Not yet built.)
11	76.3	638.5	635.5	Ohio	Wellsburg, W. Va.
12	87.0	631.2	628.2	W. Va.	Two miles above Wheeling, W. Va. (Not yet built.)
13	95.8	622.8	620.8	W. Va.	McMechen, W. Va.
14	113.8	615.5	612.5	Ohio	Woodland, W. Va. (Not yet built.)
15	128.9	607.2	604.2	Ohio	New Martinsville, W. Va. (Not yet built.)
16	146.4	599.4	596.4	Ohio	Ben's Run, W. Va. (Not yet built.)
17	167.4	591.6	588.6	Ohio	Four miles above Williamstown, W. Va. (Not yet built.)
18	179.3	583.4	581.1	Ohio	Four and one-half miles above Parkersburg, W. Va.
19	191.4	577.2	575.2	W. Va.	Little Hocking, O. (Abutment is built.)
20	201.7	569.5	566.5	W. Va.	Belleville, W. Va. (Not yet built.)
21	213.8	562.0	559.0	Ohio	Portland, O. (Not yet built.)
22	220.1	556.4	553.4	W. Va.	Ravenswood, W. Va. (Not yet built.)
23	230.6	548.6	545.6	Ohio	Milwood, W Va. (Not yet built.)
24	242.0	540.6	537.5	Ohio	Graham, W. Va. (Not yet built.)
25	260.0	533.5	530.5	W. Va.	Five miles above mouth of Kanawha River. (Not yet built.)
26	278.0	524.5	521.5	W. Va.	Hogsett, W. Va. (Nearly completed.)
27	300.3	517.0	514.0	Ohio	Four miles above Guyandotte, W. Va. (Not yet built.)
28	310.9	510.6	507.6	Ohio	Huntington, W. Va. (Not yet built.)
29	319.4	503.5	500.5	Ky.	Three miles below mouth of Big Sandy River. (Not yet built.)

GREAT KANAWHA RIVER LOCKS.

The tables of elevations and distances at the locks on the Little and Great Kanawha rivers were also received from

Captain Altstaetter's office through Lieutenant L. M. Adams, of the Wheeling office, who transmitted the data with the following letter:

UNITED STATES ENGINEER'S OFFICE.

Post Office Box 75.

Wheeling, W. Va., August 5, 1910.

Dr. I. C. White, State Geologist,
Morgantown, W. Va.

Dear Sir:

1. In reply to your letter of July 28, 1910, I enclose herewith a copy of the annual report for the Wheeling district for the year 1903, and invite your attention to the tide references marked on page 1724, which will give you the information asked for regarding the Great Kanawha river.

2. Below is the information desired relative to the Little Kanawha river. The datum is Sandy Hook, the same as for the Ohio river.

For and in absence of Captain Alstaetter:

Very respectfully,

(Signed) L. M. ADAMS,

First Lieutenant, Corps of Engineers.

Elevations of Lock Walls and Dams on the Great Kanawha River.

Lock No.	Locks. Dist'nc's from mouth of river	Locks. Original low water.	Tide reference. Miter sill.	Tide reference. Top of wall.	Dams. Tide reference. Pass sill.	Dams. Tide reference. Weir sill.	Dams. Tide reference. Upper pool.
2	84½	585.46	578.75	609.75			597.75
3	79½	571.22	566.75	596.75			587.42
4	73¼	564.44	559.75	579.75	561	567.75	573.75
5	54	548.64	543.75	565.50	546.50	552.00	559.00
6	67¼	556.22	552.50	572.50	553.50	561.50	566.50
7	44	539.63	535.50	555.50	537.50	542.00	550.50
8	36	531.27	526	547.25	529.25	533.75	542.25
9	25¼	523.64	520.50	539.50	521.25	525.75	534.25
10	19	517.41	514	533	515	519.50	528
11	1¾	510.08	504	526	508	512.50	521

TABLE OF THE TRUE MERIDIANS.

"In 1898 the United States Geological Survey in co-operation with the West Virginia Geological Survey established true meridians at the county seat of each county in the State. These lines were marked with stone monuments and aluminum tablets.

"The variation of the magnetic compass in West Virginia is about three minutes of arc per annum to the west, so that declination at any date is obtained by adding three minutes for each year from the date of the actual determination."

The following description of these monuments and declinations in the three counties are taken from Volume I.

JACKSON COUNTY.

Ripley.

Location: In southwest corner of courthouse grounds.

Station Mark: Sandstone column 42"x8"x8"; set 36" in ground in southwest corner of courthouse grounds. Copper plate in center of stone.

Reference Marks: Southwest corner of Hassler Hotel, S. 73° W., 111.3 feet; southwest corner of Clerk's office, N. 74° E. 158.8 feet; southeast corner of courthouse, N. 44° E., 194.2 feet.

Distant Mark: North of station 334.5 feet. It is a sandstone column 36"x8"x8"; set 36" in ground, near northwest corner of courthouse grounds. Aluminum bolt in center of stone. Reference marks of same; northwest corner of courthouse, S. 2° W. 224.2 feet; J. M. Wright's house N. 46 feet.

Resident Referee: G. B. Crow, County Clerk.

Magnetic Declination: 1° 25′ W., 10:30 a. m., November 25, 1898. Mean annual change +03′, approximately.

MASON COUNTY.

Point Pleasant.

Location: In the grounds of the High School.

Station Mark: Column of sandstone 42"x8"x8"; set 36" in ground, in the center of which is a copper plate.

Reference Marks: Southeast corner of school building, N. 46° W., 125.2 feet; northeast corner of school building, N. 23° W., 179.5 feet; northeast corner of school grounds N. 15° E., 180.5 feet.

Distant Mark: North of station, 337.6 feet. It is a sandstone column 36″x8″x8″; set in ground, in the jail yard. Aluminum bolt in center of stone. Reference marks of same: Northwest corner of jail, N. 80° E., 25.8 feet; southwest corner of jail, S. 10° W. 61.6 feet.

Resident Referee: J. P. R. B. Smith, County Clerk.

Magnetic Declination: 1° 21′ W., 10:00 a. m., November 21, 1898. Mean annual change +03′, approximately.

PUTNAM COUNTY.

Winfield.

Location: In the courthouse grounds opposite the jail.

Station Mark: Column of sandstone 42″x8″x8″; set 36″ in ground, in the center of which is a copper plate.

Reference Marks: Southwest corner of jail, 80 feet; northwest corner of jail, 57.3 feet; northwest corner of McLean's office, 21.8 feet; southeast corner of jail yard, 15.1 feet.

Distant Mark: North of station 308 feet. It is a sandstone column 36″x8″x8″; set 36″ in ground on the north side of Main street. near the back of Hanly & Craighill's store. Aluminum bolt in center of stone. Reference marks of same: Southeast corner of Hanly & Craighill's store, 55.6 feet; northwest corner of Hanly & Craighill's store, 4.6 feet; it is set on the inside of the pavement.

Resident Referee: R. A. Salmons, County Clerk.

Magnetic Declinations: 1° 30′ W., 10:40 a. m., November 18, 1898. Mean annual change +03′, approximately.

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